# Corporate Payout Policy, Cash Savings, and The Cost of Consistency: Evidence from a Structural Estimation*

HAMED MAHMUDI†

*Rotman School of Management, University of Toronto,*

*105 St George street, Toronto, Ontario M5S 3E6, Canada*

MICHAEL PAVLIN‡

*Rotman School of Management, University of Toronto,*

*105 St George street, Toronto, Ontario M5S 3E6, Canada*

August 19, 2010

**Abstract**

We develop a dynamic model in which firms choose their optimal financing, investment, dividends, and cash holdings while facing costly equity issuance, debt and capital adjustments costs, and taxed interest on cash balances. We solve the model numerically to estimate the volatility of payout and optimal level of cash holdings. Comparing these results with a large sample of U.S. firms from 1988 to 2007, we show that on average firms excessively smooth their payout while maintaining larger than optimal levels of cash (excess cash) on their balance sheets. We further extend the base-case model to capture the effect of a manager, who perceives a cost to cutting payout. Applying simulated method of moments (SMM) to the dynamic model we infer the magnitude of this downward adjustment cost. In particular, we find that a managerial preference for payout smoothing leads to increased accumulation of excess cash. Estimated payout consistency cost is larger for firms which are larger, have more dispersed analyst forecasts, which compensate their CEOs with low pay-performance packages, have larger institutional holdings, and pay larger fractions of their payout as dividends. Applying SMM to a recent subsample of the data (2002-2006), we show that the parameter of managerial preference for consistent payout continue to account for a similar equity value loss of approximately 7%.

*JEL Classification:* G31; G35; G32; C15

*Keywords:* Corporate Payout Policy; Payout Smoothing; Simulated Method of Moments

*This paper benefited extensively from discussions with Jan Mahrt-Smith, Craig Doidge, Raymond Kan, Sergei Davydenko, and Marcel Rindisbacher. We are also grateful for suggestions from an anonymous referee which have greatly improved the paper. We would like to thank the Rotman Finance Lab for providing computational facilities which made this study possible. All errors are the authors sole responsibility. This paper was previously circulated under the title "What Drives Corporate Excess Cash? Evidence from a Structural Estimation"

†E-MAIL: HAMED.MAHMUDI07@ROTMAN.UTORONTO.CA

‡E-MAIL: MICHAEL.PAVLIN06@ROTMAN.UTORONTO.CA

# Corporate Payout Policy, Cash Savings, and The Cost of Consistency: Evidence from a Structural Estimation

**Abstract**

We develop a dynamic model in which firms choose their optimal financing, investment, dividends, and cash holdings while facing costly equity issuance, debt and capital adjustments costs, and taxed interest on cash balances. We solve the model numerically to estimate the volatility of payout and optimal level of cash holdings. Comparing these results with a large sample of U.S. firms from 1988 to 2007, we show that on average firms excessively smooth their payout while maintaining larger than optimal levels of cash (excess cash) on their balance sheets. We further extend the base-case model to capture the effect of a manager, who perceives a cost to cutting payout. Applying simulated method of moments (SMM) to the dynamic model we infer the magnitude of this downward adjustment cost. In particular, we find that a managerial preference for payout smoothing leads to increased accumulation of excess cash. Estimated payout consistency cost is larger for firms which are larger, have more dispersed analyst forecasts, which compensate their CEOs with low pay-performance packages, have larger institutional holdings, and pay larger fractions of their payout as dividends. Applying SMM to a recent subsample of the data (2002-2006), we show that the parameter of managerial preference for consistent payout continue to account for a similar equity value loss of approximately 7%.

*JEL Classification:* G31; G35; G32; C15

*Keywords:* Corporate Payout Policy; Payout Smoothing; Simulated Method of Moments

# 1 Introduction

Since Lintner (1956) it has been widely acknowledged that managers have a tendency to smooth corporate dividends.[1] While it is well understood that firms prefer to practice a consistent payout policy, there is no clear explanation regarding why managers choose to smooth dividends, nor does there exist compelling evidence that this behavior enhances shareholder value. Another outstanding puzzle in corporate finance, is the question of why corporations accumulate excessive liquid assets.[2] This gap in our understanding persists despite the close ties decisions on corporate cash holdings have with strategic corporate decisions, in particular payout policy. Given the close relationship between corporate payout and saving policies, these two puzzles should to be addressed simultaneously.[3] In this paper, using an agency explanation, we shed light on the payout smoothing puzzle in cooperation with the excess cash puzzle. We study how manager-shareholder conflicts, more specifically a manager's perceived cost associated with payout reductions, distort corporate payout and saving decisions. We also estimate the magnitude of this cost as well as the shareholder value loss due to this distortion.

Corporate payout, savings, financing and investment policies are necessarily intertwined decisions made by a manager while taking the future of the firm into account. Under a residual payout policy, corporate savings and financing decisions are optimally selected, after which firms distribute the remaining cash to their shareholders. The savings decisions should be designed to balance trade-offs between internal and external resources for financing current and future investments in the presence of costly access to capital markets while also considering the tax on distributions to investors. However, increasing cash holdings is associated with a tax penalty on interest earned and a postponement of immediate distributions.

However, the empirical literature has suggested that managers who are responsible for both financial and real decisions of the firm, may deviate from the first-best policies by reducing corporate payout and stockpiling cash within the firm. In the spirit of Jensen (1986), managers may divert cash resources away from activities maximizing equity value, resulting in an agency problem between shareholders and managers.[4]

Jensen (1986) and Easterbrook (1984) suggest that paying a dividend that is both high

[1] For evidence on dividend smoothing also see Fama and Babiak (1968), Brav et al. (2005) and Aivazian et al. (2009).

[2] In 2006, the sum of all cash and marketable securities represented more than 17% of the sum of all assets for publicly traded US firms, reflecting a substantial increase from 5% in 1990.

[3] While Harford et al. (2008) provide some empirical evidence consistent with excessive spending of excess cash for firms with weaker corporate governance, they acknowledge that it is theoretically unclear how a self-interested manager will choose between paying out, spending, and stockpiling free cash flow.

[4] Empirical studies such as Dittmar and Mahrt-Smith (2007) and Faulkender and Wang (2006) show that \$1.00 of retained cash is valued at only \$0.42 to \$0.88. This is consistent with the agency cost of free cash flow proposed by Jensen (1986).

and smooth forces firms to raise external capital to meet their financing needs. They argue this exposure to the discipline of capital markets could reduce agency costs. However, as we show, a manager who perceives a cost to cutting dividends would have an incentive to pile up excess cash to avoid future reductions in dividends. The joint determination of payout and cash savings by the manager, and the dynamic effect of requiring smooth dividends which in turn motivates even larger levels of savings are usually ignored in this remedial view of dividend smoothing. The empirical investigations on why firms smooth their payout, what type of firms partake in payout smoothing and what affects the degree of dividend smoothing have led to conflicting and ambiguous results.[5] We suggest, these inconclusive empirical findings could be due to disregarding the joint determination of variables such as payout ratio, market-to-book ratio, operating profits, leverage, capital expenditures and cash holdings. A structural estimation, as we propose, is the most reliable approach to avoid these sorts of endogeneity problems.

We present a structural model which captures the trade-offs described earlier and exploit this model to predict optimal levels of payout and cash holdings for firms which invest in capital, save cash, raise equity, issue/retire debt, and pay dividends, all under uncertain productivity. Our dynamic structural model considers the optimal financial and investment policy for a firm facing a broad set of frictions: corporate and personal taxation, flotation cost for debt, tax penalty for holding cash, and linear-quadratic costs of external equity.

First, we consider this model under first-best assumptions where the manager maximizes the value of equity in the absence of any agency conflicts. Parameters of this model are set to exogenously chosen values. The first-best solution motivates our later investigation of a set of second-best policies. Similar to other dynamic structural models which include dividends such as Hennessy and Whited (2007), our base-case model predicts payouts which are far too volatile to match the variance of the empirical payout. We propose an agency model to provide an answer to what motivates corporate payout smoothing. Furthermore, our agency model provides insight into high levels of cash holdings and low levels of investment volatility. This model considers a maximization problem faced by a manager who perceives a downward adjustment cost from cutting payouts when making financial and real decisions within the firm.

Contrasting our first-best solution with empirical data shows that managers tend to smooth firms' payout; the variance of payout in the simulated panel (0.0025) is significantly larger than the same ratio in the empirical panel (0.0015). This is consistent with the results of the structural model from Hennessy and Whited (2007) which overshoots the empirical variance of payout by a factor of three. The empirical variance of investment-to-assets is approximately half as large as the simulated moment (0.0069 versus 0.0139). Our first-best simulated panel also shows that firms on average maintain significantly more cash than can be explained through the dynamic

[5] See Leary and Michaely (2010), Aivazian et al. (2009), Li and Zhao (2008), and Booth and Xu.

trade-off model alone. The average cash-to-assets ratio from the simulated panel (0.1631) is four times smaller than the corresponding empirical moment (0.0414). This is consistent with the empirical literature on cash holdings which argues that firms on average maintain too much cash.[6]

To rigorously investigate the motives underlying these deviations from optimality, we use observed corporate financing choices to infer the value of a hidden parameter describing the perceived cost to cutting dividends. Using Simulated Method of Moments (SMM), the value of this parameter is estimated for the agency model. In particular, in the agency model the manager's objective function is extended from solely maximizing value of equity by adding a linear function for the magnitude of the reduction in payout. This allows insight into the magnitude of the disutility that managers perceive when cutting payouts.

We also estimate other parameters such as the persistence and volatility of the shocks to cash flow. These two parameters are highly influential on the precautionary motives for cash holdings. We also use SMM to estimate the payout tax schedule parameter which pins down the marginal tax rate of corporate payout. Including these other parameters within the SMM procedure assures a robust estimation for the agency parameter. Furthermore, we estimate the parameters for the recapitalization cost of debt and the adjustment cost of capital. These parameters directly influence cash holdings, payout, and variance of investments and are therefore included as unknown parameters in the SMM procedure. We also include parameters which describe the quadratic equity issuance cost.

The SMM procedure minimizes the distance between simulated and empirical moments which results in consistent estimates of the unknown parameters. The results of this estimation answer the following question: What magnitude of managerial perceived costs for cutting payout best explains observed payout, savings, financing, and investment patterns?

In our agency model the distortion in the manager's utility function is in the form of a disutility for reductions of corporate payout. [7] As a consequence of this cost, the manager will smooth the firm's payout. She will also keep high cash levels to decrease both the probability of cutting payouts and the magnitude of the required reduction in payout. We acknowledge that this is only one of many possible ways to model agency conflicts between a manager and shareholders which may lead to excess cash holdings. However, this agency model is primarily motivated by the discrepancy between the variance of corporate payouts in the simulated base-case panel versus the empirical panel rather than a desire to explain excess cash holdings. Nevertheless, in our agency model the low payout variance result can be explained contingent on the diversion

[6]See Dittmar and Mahrt-Smith (2007), Faulkender and Wang (2006), Opler et al. (1999)

[7]We do not intend to directly explore the sources of this disutility imposed on the manager. However, in later sections we perform a cross sectional analysis which lends support to several possible explanations for payout smoothing.

of resources to cash holdings. We show in our comparative statics exercises, all else being equal, when managers perceive larger costs to cutting payout, the chosen level of cash holdings would be higher to prevent a possible shortfall in the next period's dividends. These results further illustrate the importance of taking into account the joint determination of payout and cash holdings.

To provide a robust estimation of the model parameters, the SMM moments must be carefully selected. In addition to being meaningful descriptors of manager-firm behavior, the moments must be sufficiently informative about model parameters. Following Hennessy and Whited (2007), we also choose moments which are commonly discussed in the empirical literature. Examples include variance of distributions which is informative about the managerial payout consistency cost parameter and the first and second moments of the ratio of cash-to-assets which are informative about both the equity issuance cost and the managerial perceived cost to cutting payout. Financial ratios such as the first and second moments of the ratio of equity issuance-to-assets are also included among the moments. We include leverage ratio, variance of long-term debt-to-assets and the frequency of long-term debt reductions which are informative about the debt recapitalization cost parameters. In addition to the above moments, we include the payout ratio, the frequency of distributions, and the correlation of payout and cash. The final important category of moments we include are those which are informative about the firm's cash flow. In particular, we make use of the second moment of investment and also the serial correlation and the standard deviation of shocks to income-to-assets.

The empirical sample is constructed from the entire sample of Compustat firms. Our sample includes non-financial, unregulated firms from the annual 2006 COMPUSTAT industrial files.[8] Our estimation results indicate that the linear payout consistency cost parameter is equal to 0.113 and is statistically significant at a 5% level. This translates to a typical firm behaving as if it has a manager who associates an average cost for cutting payout equal to $83,000 for a million dollars of shareholders' equity value. These SMM parameter estimates support the view that on average managers 1) anticipate fairly large costs associated with cutting payout, and 2) that corporations are sensitive to this managerial agency parameter. Our estimates also show a loss of approximately 7% in equity values due to this agency problem.

Most theories of payout smoothing are motivated either by information asymmetry or agency explanations. For example, studies such as Almeida et al. (2004) and Bates et al. (2009) argue that if future dividend cuts are viewed as costly, financially constrained firms will be reluctant

[8]We do not include data from 2007-2010 because our model is not intended to capture exogenous shocks on firm's borrowing costs. The source of uncertainty in our model is only due to income shocks, represented by a first-order autoregressive process. A model with structural breaks and shocks on borrowing costs is more appropriate to explain the observed data in the recent era in the financial markets. This could be an interesting extension that is beyond the current scope of the paper.

to increase dividends even following a positive cash flow shock. Moreover, because smooth dividends convey more information than erratic dividends, these arguments suggest firms which suffer from greater information asymmetry have a stronger incentive to smooth their dividends. This prediction is also consistent with signaling explanations such as Kumar (1988), Kumar and Lee (2001) and Guttman et al. (2001) which argue that semi-separating equilibria in which firm types pool within a certain range and separate out of that range, could explain dividend smoothing. These explanations also predict more payout smoothing among firms which have higher precautionary motives for cash savings.

Agency explanations, such as Easterbrook (1984) and Jensen (1986), suggest that paying out dividends that are both high and smooth leads to lower agency costs of free cash flow as self-interested managers are forced to face the discipline of capital markets more often. Other studies such as Allen et al. (2000) argue that institutional investors who may also lower agency costs through their monitoring activities, due to their tax status are attracted to firms paying larger dividends. These institutional investors, in the case of cutting dividends, can impose large costs on the management. Hence, dividend smoothing is predicted to be more evident among firms with higher levels of institutional holdings.

Both information asymmetry and agency explanations of payout smoothing assume that payout smoothing is adopted to improve shareholders value. This may appear to conflict with our estimated perceived cost of cutting payouts and the associated equity loss to the shareholders from payout smoothing. However, these estimations are done in comparison to the first-best results in which no conflict exists between the manager and shareholders. Our paper does not propose to de-emphasize the possible value-enhancing effects of dividend smoothing in the presence of other possible agency problems.

We explore these predictions and possible heterogeneity in the impact of this managerial agency problem on payout variance and firm cash holdings by performing estimations on sub-samples of firms split by a variety of manager-firm characteristics. Through this exercise we find some supporting results for each of these payout smoothing explanations.

First, we re-estimate the model using sub-samples obtained by splitting the full sample according to the firm size. We find large differences between the magnitude of the perceived costs for the managers of small and large firms. This suggests the full sample parameter estimates mask heterogeneity across firms and managers. The managerial payout consistency cost parameter is greater for the sample of larger firms. This is consistent with the empirical fact that larger firms have on average lower payout variance.

The observed average cash-to-assets ratio is higher for smaller firms. At first glance, it is not obvious what is driving this result. While we illustrate with sensitivity analysis that the smaller payout consistency cost parameter leads to smaller cash balances, the effects of higher cash flow volatility and larger equity issuance costs outweigh this force and result in larger cash holdings. The value loss due to the managerial preference for smooth payout is larger (9%) for the sample of large firms in comparison to the loss for the sample of small firms (1%).

The second sample split is based on information asymmetry measured by analyst forecasts dispersion. This cross-sectional analysis produces intuitive results. Firms suffering from more information asymmetry in the market tend to have managers with larger preferences for smooth payouts. Interestingly, this result is masked when the empirical results are looked at in isolation since the payout variances are similar between the subsamples of high and low information asymmetry firms.

Consistent with Easterbrook (1984), we find that firms with managers who are compensated with high powered incentive packages, proxied by pay-performance-sensitivity (PPS), tend to have managers who associate lower costs with cutting payouts. Supporting Allen et al. (2000), firms with larger institutional ownership behave as if they have managers with larger preferences for smooth payout. Our estimates also result in larger managerial payout consistency costs for firms which pay larger fractions of their payout in the form of dividends rather than share repurchases. This is consistent with the empirical literature which suggests that managers do not smooth repurchases in the same manner as they smooth dividends (e.g. Skinner (2008)).

Finally, by re-estimating our model for the subsample of firm years 2002-2007, we find that during recent years the magnitude of the preference for smooth payout has not changed substantially. A recent empirical study by Bates et al. (2009) argues that the recent increase in US corporate cash holdings is because the firms' cash flows have become riskier. Supporting this, we find that the increase in the volatility of cash flows in recent years can explain the higher level of cash holdings in the last five years.

In order to provide intuition regarding the underlying economic forces in the model, we perform a set of sensitivity analyses through comparative statics. These results show that a higher managerial payout consistency cost leads to larger cash reserves and also smaller payout ratios and equity issuances and are inconsistent with the remedial view of payout smoothing suggested by Jensen (1986) and Easterbrook (1984). From our results it is not clear that imposing a large cost to cutting payout onto a manager who has to make joint decisions regarding firm's financial policies would result in a lower agency cost of free cash flow for the firm. This points out the significance of the structural approach in enabling us to account for endogeneity among corporate policies. It is important to note that the empirical positive association between cash holdings and payout smoothing documented in Leary and Michaely (2010) could also be due to the endogenous relationship between these policies. This interpretation differs from the Leary and Michaely (2010) explanation that cash cows adopt payout smoothing to reduce agency costs.

While Leary and Michaely (2010) finds support only for the agency based explanations of payout smoothing, we show information asymmetry could also contribute to this practice. As in their paper, we also document that payout variance is not related to measures of information asymmetry. It is only by estimating the unobservable variable of the manager's disutility from cutting payouts that we are able to bring to light the effect of information asymmetry on the preference for payout smoothing. Our cross sectional results highlight the importance of structural estimation for corporate finance studies where endogeneity of certain key variables is a significant concern and when model elements are unobservable. With this insight in mind, it is not surprising that the literature has produced such mixed evidence on the motives for payout smoothing.

The remainder of this article proceeds as follows. In Section 2, we introduce the related studies and situate the paper within the existing literature. Section 3 presents the model. In Section 4, we first present the results of the base-case model and then describe the results of the SMM procedure. This section also presents sensitivity analysis and estimation results for various sample splits. Finally, Section 5 concludes. Explanations of the computational methodology used in this paper are included in the Appendix.

## 2 Related Literature

This paper primarily relates to three major areas of corporate finance literature: the structural literature on dynamic corporate policies as well as the empirical literatures on payout smoothing and cash holdings.

During the past 50 years empirical studies such as Lintner (1956), Fama and Babiak (1968), and Choe (1990), have convincingly demonstrated that dividend smoothing is prevalent.[9] In a recent survey study, Brav et al. (2005) report that 94% of managers of dividend paying firms strongly or very strongly agree that they actively try to avoid reducing dividends. Firms may be conscious of an implicit bargain with shareholders at the time they invested in equity to provide a steady stream of payouts. In the presence of information asymmetry in the market, signaling motives to convey credible information to the investors could also lead to payout smoothing. It has also been argued that payout smoothing is employed as a remedy to mitigate certain agency conflicts such as the free cash flow problem. All these motives may lead to cross sectional differences among firms regarding their payout smoothing behavior.

Leary and Michaely (2010) examines these different motivations and finds support for agency explanations rather than information justifications of smoothing behavior.[10] They find that

[9]For a complete survey on payout policy see DeAngelo et al. (2009).

[10]See Allen et al. (2000), Easterbrook (1984) and Jensen (1986) for agency explanations. See Kumar (1988), Brennan and Thakor (1990), and Guttman et al. (2001) for dividend smoothing theories based on asymmetric information.

younger, smaller firms, firms with higher earning volatility smooth less. Firms with high cash holdings, low growth opportunities and higher level of institutional ownership smooth more. Aivazian et al. (2009) find that the decision to smooth dividends depends in part on public market access as proxied by bond ratings. They show that firms smooth more when they raise debt in the public "uninformed" bond markets rather than in the private informed bank market. Contrary to Leary and Michaely (2010), they conclude that the dividend smoothing decision is related to information asymmetry between the managers and the firm's creditors.

Our paper differs from all previous studies as we present the first dynamic structural model of payout smoothing. Our structural model does not directly tackle the question of why firms smooth their payout, instead it focuses on estimating the perceived cost of cutting payout imposed on the manager. We do contribute to the empirical cross-sectional studies by re-estimating managerial payout consistency cost for different subsamples of the data. We explore different explanations and find some supporting evidence for both agency and information explanations.

Among structural models of corporate policies, dynamic studies such as Riddick and Whited (2008) and Gamba and Triantis (2008) investigate the role of cash savings when the firm invests and saves in the face of costly external equity finance. Gamba and Triantis (2008) presents a quite general dynamic model, allowing for cash holding as well as separate debt and equity finance. Like us, they do not include risky debt.[11] On the other hand, their model does not include any source of managerial and debt-related agency problems. Their main contribution is providing an explanation for how debt flotation costs can lead to simultaneous cash and debt holdings. Riddick and Whited (2008) also investigates why corporations accumulate liquid assets. They document a negative corporate propensity to save; that is, the firm counteracts movements in cash flow with opposite movements in savings. Unlike our model, they do not include any sort of debt (risky or risk-free). They also exclude any agency issues as their focus is not on shareholder-manager conflicts. Neither of these structural models broach the subject of payout policy.

Our paper is also closely related to Hennessy and Whited (2007), which utilizes a structural model and SMM to study a firm that invests in the face of costly external equity financing and fixed costs of capital adjustment. As in our paper, Hennessy and Whited (2007) finds a suboptimal level of distribution variance indicating managerial preference for payout smoothing. However, unlike our model which addresses this discrepancy by estimating a payout consistency cost, Hennessy and Whited (2007) leaves the payout smoothing question unanswered.

Within the crowded dynamic cash literature, a recent study by Moyen and Boileau (2009)

[11] As elaborated in Appendix D, the exclusion of risky debt from the model makes it more difficult to match the average cash-to-assets ratio. However, The inclusion of risky debt alone cannot justify the high level of excess cash.

presents a model in which precautionary savings can also arise because of firm's liquidity constraints. They argue that the capital share of revenues has become smaller over time, thus, the prudence motive is no longer empirically relevant. In a model with risk-free debt and no agency, they show that the liquidity constraint motive can by itself explain the observed increase in cash holdings. While we investigate the role of agency in explaining payout smoothing, we also illustrate that the agency problem we study could lead to an increase in cash balances.

Besides our paper, there exists only one other structural model which investigates the role of *agency conflicts* on corporate finance decisions. Nikolov and Whited (2010) estimates a dynamic model of firm investment and cash accumulation in the presence of shareholder-manager agency conflicts. In their study the source of agency is different from ours. They model agency conflicts arising from limited managerial ownership, bonuses based on short term profits, and managerial empire building preferences. They find that on average managers like to build empires, and use too much costly external financing.

The agency sources studied by Nikolov and Whited (2010) do not relate to the managerial payout consistency cost which is the focus of our paper. Moreover, they do not distinguish between debt and equity incorporating both into "external finance". To their credit, Nikolov and Whited (2010) has the advantage of modeling compensation related agency which we do not touch on. They also investigate the effect of corporate governance on the magnitude of managers' empire building preferences. Overall, while the focus of the papers are different, our study is in many ways complementary to Nikolov and Whited (2010), as we capture another source of agency conflicts and its effect on corporate decisions.

Our paper also relates to the empirical literature on how firms allocate their cash flows between investments, payouts and cash savings. Harford et al. (2008) finds that, in the US, firms with weaker corporate governance do not payout their excess cash through dividends. Rather, they choose to distribute excess cash by methods that do not impose any commitment on their future payouts such as share repurchases. Moreover, these weakly controlled managers actually save less cash and choose to spend cash quickly on acquisitions and capital expenditures, rather than hoard it.

Our work is related not only to Harford et al. (2008), but also to a large empirical literature which shows piling up excess cash and not distributing it to the shareholders can lead to value decreasing decisions, and that the market value of these cash reserves is lower when firms are poorly governed and there is weak shareholder protection. This includes studies by Dittmar and Mahrt-Smith (2003), Harford (1999), Kalcheva and Lins (2007), Pinkowitz et al. (2006) and Mikkelson and Partch (2003). These papers focus primarily on the effects of excess cash rather than the motives behind the accumulation of excess cash in the first place. The only empirical paper that focuses on possible explanation for the high level of observed excess cash is Bates et al. (2009). They show that riskier cash flows in recent years, particularly concentrated among smaller high tech firms have caused the dramatic growth of excess cash. Although the main focus of our paper is not excess cash, given that corporate cash and payout policy are intertwined, our theory allows us to investigate these empirical results more robustly.

# 3 The Model

## 3.1 The Base-Case Model

The base-case model represents a firm maximizing its equity value. We construct a discrete-time, infinite-horizon, partial equilibrium, stochastic model of payout, debt, investment and cash holdings. In our model, firms trade off a tax benefit of debt against an adjustment and a flotation cost of debt. Different firms are characterized by different realizations of the stochastic process. The firm maximizes equity value by choosing its payout, investment, cash holdings, and debt policy. All claimants, equity and debt, are risk neutral. The equity value $V_t$ takes the form:

$$V_t = D_t + T(D_t) + \Lambda(D_t) + \frac{1}{1 + (1 - \tau_b)r} E_t[V_{t+1}] \tag{1}$$

where $r$ is the discount rate, $\tau_b$ is the personal interest income tax rate, and $E_t$ is the conditional expectation at period $t$. Payouts are represented by the variable $D_t$.

Dividends and capital gains are taxed according to the tax schedule $T(D_t)$. In this model we do not directly differentiate between dividends and share repurchases. However, because share repurchases are taxed at a lower rate, the tax schedule needs to allow firms to minimize taxes for smaller payouts by distributing them in the form of share repurchases.[12] Following Hennessy and Whited (2007) and Moyen and Boileau (2009), the payout tax schedule is convex and features an increasing marginal tax rate:

$$T(D_t) = -(\tau_d D_t + \frac{\tau_d}{\phi} \exp^{-\phi D_t} - \frac{\tau_d}{\phi}) \mathbf{1}_{(D_t > 0)} \tag{2}$$

where $\phi > 0$ is the payout tax parameter, $\tau_d$ is the tax rate, and function $\mathbf{1}_{(D_t>0)}$ equals one if $D_t > 0$, and zero otherwise. A larger $\phi$ corresponds to a higher marginal tax rate.

In this setup a negative dividend is interpreted as equity issues. Moreover, equity issuance is associated with a cost. To preserve tractability, we do not model costs of external equity as the outcome of an asymmetric information problem. Instead, consistent with Riddick and Whited

[12] Securities and Exchange Commission's (SEC) concern for stock price manipulation and U.S. Internal Revenue Service (IRS) regulations to prevent replacement of dividends with systematic share repurchases lead to smaller payouts being in the form of repurchases while larger distributions are done through tax disadvantaged dividends.

(2008), we capture adverse selection costs and underwriting fees in a reduced form fashion. The equity issuance cost is linear-quadratic and weakly convex:

$$\Lambda(D_t) = (-\lambda_0 + \lambda_1 D_t - \frac{1}{2}\lambda_2 D_t^2)\mathbf{1}_{(D_t<0)} \tag{3}$$

where function $\mathbf{1}_{(D_t<0)}$ equals one if $D_t < 0$, and zero otherwise. $\lambda_0$, $\lambda_1$ and $\lambda_2$, are positive constants. Convexity of $\Lambda(D_t)$ is consistent with the evidence on underwriting fees in Altinkiliç and Hansen (2000).

Equation (1) shows that the equity value is the sum of the expected discounted stream of dividends[13] net payout tax and equity issuance cost: $D_t + T(D_t) + \Lambda(D_t)$.

This period's depreciated capital stock and investment form next period's capital stock. The capital accumulation is thus presented as:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{4}$$

Consistent with Riddick and Whited (2008), Moyen and Boileau (2009), and Nikolov and Whited (2010), the firm purchases and sells capital at a price of one and incurs adjustment costs that are given by

$$A(K_t, I_t) = \frac{a}{2}\left(\frac{I_t}{K_t}\right)^2 K_t \tag{5}$$

where $\delta$ is the capital depreciation rate, $0 < \delta < 1$, $K_t$ is the capital stock and $a$ is the capital adjustment cost parameter that acts to smooth investment over time.[14]

The new debt issue is the difference between the new debt level chosen this period $B_{t+1}$ and the beginning-of-period debt level $B_t$:

$$\Delta B_{t+1} = B_{t+1} - B_t \tag{6}$$

The debt is specified with a maturity of one period, but can be viewed as longer term debt with a floating rate.[15] In each period, the firm can roll over its existing debt $\Delta B_{t+1} = 0$, retire some

[13] In this section we refer to any positive *payout* as *dividends*. Although, $D_t > 0$ represents the sum of repurchases and dividends.

[14] An alternative is to replace our quadratic capital adjustment cost function with a similar function which also includes a fixed cost to investment:

$$A(K_t, I_t) = cK_t\mathbf{1}_{(I_t \neq 0)} + \frac{a}{2}\left(\frac{I_t}{K_t}\right)^2 K_t$$

This functional form inspired by the empirical investment literature (Cooper and Haltiwanger (2006)), has been used in Riddick and Whited (2008) and Nikolov and Whited (2010). Although the fixed component leads to slightly higher optimal cash levels, it does not change the payout variance. Hence, we focus on the simpler quadratic cost function.

[15] We assume there are "perfect" debt covenants restricting the manager from asset sales, dividends, etc.

debt $\Delta B_{t+1} < 0$, or issue more debt $\Delta B_{t+1} > 0$ at the risk free rate.[16]

We also assume a recapitalization cost for debt. This cost includes two different components:

$$\Omega(B_{t+1}, B_t) = \frac{\omega}{2}(B_{t+1} - \bar{B})^2 + q(B_{t+1} - B_t)\mathbf{1}_{(B_{t+1} > B_t)} \tag{7}$$

The first component, similar to investment, is a quadratic cost to varying the debt level away from the target debt level $\bar{B} \geq 0$. $\omega \geq 0$ is the debt adjustment cost parameter. The second term captures the flotation cost on new debt issued. There is no additional cost associated with paying down debt.[17] Parameter $q \geq 0$ captures the linear proportional flotation cost of new debt issues. The incremental cost for issuing new debt makes the recapitalization cost of debt asymmetric.[18]

In this model, debt financing has a tax advantage as the interest is deductible by the firm at a higher rate than the interest income is taxable to individuals ($\tau_c > \tau_b$). Hence, the recapitalization cost of debt plays an important role by providing an implicit upper bound on the debt level.[19]

The firm's sources-and-uses of funds equation defines the payout:

$$\begin{aligned} D_t &= (1 - \tau_c)f(K_t; \theta_t) + \tau_c \delta K_t - I_t + \Delta B_{t+1} - (1 - \tau_c)rB_t - A(K_t, K_{t+1}) \\ &\quad -\Omega(B_{t+1}, B_t) + (1 + (1 - \tau_c)r)C_t - C_{t+1} \end{aligned} \tag{8}$$

where $\tau_c$ is the firm's tax rate, $K_t$ is the capital stock, $\theta_t$ describes the firm's underlying income shock, $(1 - \tau_c)f(K_t; \theta_t)$ is the after tax operating income before depreciation, $\tau_c \delta K_t$ is the depreciation tax shield, $I_t$ is the investment, $\Delta B_{t+1}$ is the new debt issue, $r$ is the risk free rate, $B_t$ is the debt level and $(1 - \tau_c)rB_t$ is the after-tax interest payment. The depreciation rate used for tax purposes is assumed to be equal to the true economic depreciation rate of the capital stock. The stock of cash has to be non-negative as we do not model lines of credit separately from debt issuance.

$$C_{t+1} \geq 0 \tag{9}$$

[16] The risk free-debt structure abstracts from any possible agency problem associated with the firm increasing its leverage to expropriate wealth from existing creditors. For a model which focuses on these agency problems see Moyen (2007).

[17] In the Appendix we replace the current simplified risk-free debt structure with a more elaborated risky debt in which the requested interest rate by the creditors becomes an endogenous variable changing with how far the firm is from default. Here, we settle for the simpler debt structure as 1) our focus of the paper is not firm capital structure, 2) the risky debt model presents significant computational challenges resulting in problems for the SMM procedure. Nevertheless, in the appendix we show that the base-case model with risky debt does not lead to a dramatic difference in the payout ratio and variance.

[18] The asymmetric recapitalization cost for debt is consistent with Gamba and Triantis (2008). Moyen and Boileau (2009) also shows that introduction of asymmetric recapitalization cost enhances the precautionary motive for cash holdings.

[19] We do not include a collateral constraint as it does not change our main results. Moreover, both the recapitalization cost of debt and a collateral constraint play a similar role by providing a ceiling on debt.

The firm's operating income before depreciation is presented as:

$$f(K_t; \theta_t) = \theta_t K_t^{\alpha} \tag{10}$$

Operating income before depreciation exhibits decreasing returns to scale when $0 < \alpha < 1$. The firm's income shock is represented by a first-order autoregressive process with persistence $\rho$ and volatility $\sigma$:

$$\ln \theta_{t+1} = \rho \ln \theta_t + \sigma \epsilon_{t+1} \tag{11}$$

where $\epsilon_t \sim N(0,1)$. Because the persistence parameter $\rho$ is not zero, the income shock is somewhat predictable. The firm anticipates the income shock it will face next period and chooses its investment, debt policy and cash holdings accordingly. The firm cannot perfectly foresee the income shock it will face next period.

In this model, the manager maximizes the equity value of the firm such that equations (2)-(11) are satisfied.[20] This forms the base-case model where the manager acts in the interest of all equity holders. She does not extract any sort of private benefits which may cause an agency conflict between herself and the shareholders. In the following section we will extend the model to allow the manager to perceive a cost to cutting payouts.

In the base-case model the manager's choice of payout is similar to a residual payout policy in which the positive residual after choosing the new cash level, debt level, and firm's investment, is payed out to the shareholders. The manager selects optimal levels of payout only through her other decisions.

In a model with no cost of raising equity, there would be no need for stocks of cash. That is, if $\Lambda(D_t) = 0$ then the firm can effectively manage its financing by buying and selling its capital stock and changing its financial structure. However, due to costly equity issues $\Lambda(D_t)$, the firm may save some cash to reduce expected future financing costs. The firm's optimal level of cash holdings also depends on the firm's expected future financing needs which in turn depend on the firm's production function $f(K_t; \theta_t)$ and especially on the uncertainty it faces through the shock $\theta_t$. The optimal cash holdings also relate to the firm's holdings of debt and the recapitalization cost of debt. If debt adjustments were not costly, the firm could simultaneously meet its financing needs and avoid costly equity issues by raising more debt. By including the recapitalization cost of debt hand in hand with the cost of issuing equity, we are able to address the simultaneous existence of debt, equity issues and cash balances in the firm.

In summary, our dynamic model describes a firm which at each period chooses how much dividend $D_t$ to pay, how much to invest $I_t$, how much debt to issue $\Delta B_{t+1}$ and how much cash to keep $C_{t+1}$. Constrained by equations (2)-(11) , the firm makes these choices in order to maximize

[20] This could be justified by simply assuming that the manager owns a proportion of firm's equity.

the equity value in Equation (1). The firm makes these decisions after observing the beginning-of-the-period value for the income shock $\theta_t$ and last period's choices of capital stock $K_t$, debt $B_t$, and cash stock $C_t$. The Bellman equation describing the firm's intertemporal problem is:

$$V(K_t,B_t,C_t;\theta_t) = \max_{D_t,K_{t+1},\Delta B_{t+1},C_{t+1}} \left\{ D_t + T(D_t) + \Lambda(D_t) + \frac{1}{1+(1-\tau_b)r} E_t[V(K_{t+1},B_{t+1},C_{t+1};\theta_{t+1})] \right\} \quad (12)$$

subject to Equations (2)-(11).

The model cannot be solved analytically. The solution is approximated using numerical methods. Once decision rules are obtained, a panel of firms is simulated and studied. The employed numerical method is discussed in the Appendix. However, to develop some intuition behind the optimal policy we consider the Euler equation relating the model's dynamics to changes in cash. Utilizing the envelope condition, this Euler equation can be presented as follows:

$$\begin{aligned} &1 + (\lambda_1 - \lambda_2 D_t)\mathbf{1}_{(D_t<0)} + (-\tau_d + \tau_d \exp(-\phi D_t))\mathbf{1}_{(D_t>0)} = \\ &= \frac{1+(1-\tau_c)r}{1+(1-\tau_b)r} E_t[1 + (\lambda_1 - \lambda_2 D_{t+1})\mathbf{1}_{(D_{t+1}<0)} + (-\tau_d + \tau_d \exp(-\phi D_{t+1}))\mathbf{1}_{(D_{t+1}>0)}] \quad (13) \end{aligned}$$

The optimal interior financial policy has to satisfy this condition. The right hand side represents the shadow value of cash balances, and the left hand side represents the marginal cost of external equity finance plus the marginal cost of the tax schedule on corporate dividends. If a firm saves a dollar today, it reduces the probability of having to issue new equity tomorrow. It also influences both the probability of future payout and the marginal cost of the payout tax in the next period. The firm continues to save just to the point where the gain from reducing future equity costs outweighs the tax penalty on savings.

Inspection of Equation 13 also reveals that optimal cash, investment and debt policies are clearly intertwined. In the base-case model the financing trade-offs are somewhat similar to the trade-offs in Riddick and Whited (2008). Although our base-case model also incorporates risk-free debt and tax on dividends, the fundamental trade-off is between the tax disadvantage of holding cash versus the financial flexibility provided by cash allowing the firm to avoid the cost of external equity and the recapitalization cost of debt.[21]

[21] The base-case model with risky debt, elaborated in the Appendix, adds to this trade-off which makes cash marginally more valuable resulting in higher optimal cash holdings.

## 3.2 The Agency Model

In this section we present an agency model where the objective function of the manager is modified to capture a possible perceived cost faced when dividends are cut. The maintenance of consistent dividends is a widespread practice generally taken as an article of faith. We also take this for granted as an empirical fact and focus on the estimation of the loss due to the prevalence of payout smoothing. The perceived cost of payout smoothing is present in the form of an attenuation of the manager's utility function that is linear in the magnitude of the payout reduction.[22] The Bellman equation describing the manager's intertemporal problem is

$$\begin{aligned} &V(K_t, B_t, C_t; \theta_t) = \\ &\max_{D_t, K_{t+1}, \Delta B_{t+1}, C_{t+1}} \Big\{ D_t + \Lambda(D_t) + T(D_T) + \frac{1}{1+(1-\tau_b)r} E_t[V(K_{t+1}, B_{t+1}, C_{t+1}; \theta_{t+1})] \\ &\qquad + \gamma(D_t - D_{t-1}) \mathbf{1}_{(0<D_t<D_{t-1})} \Big\} \end{aligned} \tag{14}$$

subject to Equations (2)-(11).

The constraints of the maximization problem remain unchanged from the base-case model. The magnitude of the disutility function is captured by parameter $\gamma$. To our knowledge this model is the first study which estimates the perceived cost managers associate with cutting dividends.

By construction, it is clear that the agency model will lead to a lower payout variance. However, further investigation is required to determine whether, in comparison to the base-case results, incorporating this disutility results in higher levels of cash holding. Studies such as Easterbrook (1984), and Jensen (1986) suggest that dividend smoothing could be employed to make managers less flexible and more reliant on external capital markets. They argue that this practice would make the managers pay out excess cash and face capital markets more often. In our agency model the manager is aware of possible costs she will face if the firm's dividends are cut.[23]

The perceived cost of dividend smoothing would affect both the marginal cost of keeping cash

[22] This is one of the many possible approaches to model managerial preference for smooth payout. We chose this special type of disutility after observing the suboptimal level of payout variance (relative to the base-case results) in the empirical sample.

[23] We abstract from distinguishing among different types of disutility the manager may experience in the case of cutting dividends since the main focus of the paper is to estimate the "magnitude" of the cost and the consequent loss in equity value. The cost could arise from pressure from institutional investors requesting dividends as suggested by Allen et al. (2000) or not being able to convey credible information to the market (a particular problem for firms which suffer from higher level of information asymmetry suggested by Kumar (1988), Kumar and Lee (2001) and Guttman et al. (2001)).

and the shadow value of cash balances. Keeping more cash today also decreases the probability of having to cut dividends tomorrow. Conditional on cutting dividends, higher cash levels decrease the magnitude of this reduction and consequently the manager's disutility. The earlier empirical studies usually do not account for this co-determination of cash holdings and payout. While payout smoothing could be imposed by shareholders (e.g. institutional investors) with the goal of increasing payout and reducing agency conflicts, it could lead to an increase in excess cash and further deviation from first-best corporate policies.[24] In this model, we test for this effect by employing SMM to endogenously solve for the unknown parameters. Furthermore, we allow the persistence and volatility of the cash flow shocks $(\rho, \sigma)$ and also the quadratic equity issuance cost parameters, the debt recapitalization cost parameters, the distribution tax schedule parameter, and the capital adjustment cost parameter $(\lambda_0, \lambda_1, \lambda_2, \omega, q, \bar{B}, \phi, a)$ to be endogenously estimated alongside the agency parameter.

# 4 Estimated Optimal Corporate Policies

## 4.1 The Calibration

Acquiring a solution to our base-case model, details of which are explained in the Appendix, requires values for the full set of parameters: $r$, $\delta$, $\tau_c$, $\tau_b$, $\tau_d$, $\omega$, $q$, $\bar{B}$, $\alpha$, $\phi$, $\rho$, $\sigma$, $\lambda_0$ , $\lambda_1$ , $\lambda_2$.

As in Riddick and Whited (2008), we set the parameters of the equity issues cost function from the estimations of Hennessy and Whited (2007): $\lambda_0 = 0.389$, $\lambda_1 = 0.053$, $\lambda_2 = 0.0002$. These values are their estimates of the cost of equity issues for large firms. These are conservative estimates which are just slightly above the estimates for underwriting costs in Altinkiliç and Hansen (2000).

Following recent dynamic investment studies, we set the real interest rate $r$ to 0.02. This lies between the values chosen by Moyen and Boileau (2009) and Riddick and Whited (2008).[25] The depreciation rate $\delta$ is set to 0.10. The tax rates are set to reflect the US corporate and personal tax rates of 35% and 25%: $\tau_c = 0.35$ and $\tau_b = 0.25$. The marginal dividend tax rate is set to $\tau_d = 0.25$, approximately the value of 0.2325 calculated by Moyen and Boileau (2009) for the time period 1995-2006. We also set the distribution tax parameter $\phi$ to 0.45. Later, we will endogenously estimate this parameter when solving the agency model. For the adjustment cost parameter we turn to Nikolov and Whited (2010) which estimate $a = 0.2471$.

[24] We do not intend to ignore the possible upsides of payout smoothing since in the presence of additional agency conflicts, we can not predict what would have been the alternative policy in the absence of smoothing. However, in comparison to the first-best results, payout smoothing would always lead to an equity value loss for the shareholders.

[25] Moyen and Boileau (2009) uses the average of the monthly annualized t-bill rate deflated by the consumer price index to determine the risk free rate: $r = 1.6091\%$.

Following Gamba and Triantis (2008), the serial correlation of shock $\rho$ is set at 0.62. Similar to Moyen (2004), the standard deviation of the shock $\sigma$ is set at 0.20. These values are between Hennessy and Whited (2007) and Nikolov and Whited (2010), which respectively estimate the persistence to 0.56 and 0.67, and the standard deviation of the shock to 0.11 and 0.31. When solving the agency model we estimate these two parameters endogenously.

Similar to Gamba and Triantis (2008), the flotation cost of new debt issues is set to $q = 0.02$. The adjustment cost of debt $\omega$ and the constant debt level $\bar{B}$ are set to 0.02 and 14, respectively.[26] Furthermore, following Moyen (2004) and Gamba and Triantis (2008) we set the production return-to-scale parameter $\alpha$ at 0.45.

Given these parameter values, the base-case is solved numerically as described in the Appendix. The resulting series $K_{t+1}$, $\Delta B_{t+1}$, $D_t$, $C_{t+1}$ and $V_t$ are simulated from random outcomes of the income shock $\theta_t$. A sample of 20,000 firms is generated, where each series in the panel defines a firm.[27] Dropping the first part of the series (the first 20 periods) allows us to observe the firm after it has worked its way out of a possibly suboptimal starting point.

In the agency model, we estimate unknown parameters using SMM. This procedure chooses the payout consistency cost parameter, the volatility and persistence of the cash flow shocks, equity issuance cost parameters, debt recapitalization cost parameters, the capital adjustment cost parameter and the distribution tax schedule parameter to minimize the distance between model-generated moments and the corresponding moments from actual data. Because the moments of the model-generated data depend on the structural parameters utilized, minimizing this distance will provide consistent estimates under the conditions discussed in Appendix B.

## 4.2 Matching Moments

The twinned goals of the SMM procedure are to first, generate a model which provides a useful and accurate predictor of the behavior of the sampled firms and to second, provide meaningful estimates of the underlying parameters. The moments selected for matching within the SMM procedure form the bridge in this mapping between the empirical data and structural model. To convincingly achieve the above goals these moments must be selected in a principled manner.

The first goal requires that the empirical moments are commonly employed in finance practice; if the moments are not interesting then the predicted behavior will be of little value. Towards this goal, we select moments which are used in the literature and provide a broad picture of the structure and dynamics of the firms financing and productivity. We also select moments which

[26]To put the value of $\bar{B}$ in perspective, we also calculate the ratio of $\bar{B}$ to capital $K$. In our base-case model, this ratio is roughly equal to 0.30.

[27]Michaelides and Ng (2000) states that a simulated sample of about 10 times the size of the actual data is required in order to produce reliable estimates from an indirect inference estimator. This is chosen simply because we intend to employ SMM on the agency model in the next section.

provide a focused picture of payout policy since these decisions are of particular interest to this study. To be convinced that the second goal was achieved one requires that other parameter settings cannot explain the empirical moments. To correctly identify the parameter values we ensure that there are a sufficient number of moments informative about each parameter. These requirements of selecting meaningful and informative moments in large part echo the selection procedures employed in other SMM estimates such as Hennessy and Whited (2007) and Nikolov and Whited (2010). We now proceed to discuss how the selected moments provide a meaningful picture of the sampled firms.

We attempt to match the first and second moments of the ratio of cash holdings-to-assets, the payout ratio, the payout variance, the frequency of positive payout, the first and second moments of equity issuance-to-assets, the variance of investment-to-assets ratio, the average of debt-to-assets ratio, the second moment of long-term debt-to-assets ratio, frequency of long-term debt reduction, the covariance of cash and payout, and finally the ratios of the standard deviation of the shocks to income-to-assets and the serial correlation of income-to-assets. These moments are used to estimate parameters ($\gamma$, $\lambda_0$, $\lambda_1$, $\lambda_2$, $a$, $\sigma$, $\rho$, $\omega$, $\bar{B}$, $\phi$).

The payout ratio, the variance of payout and the frequency of positive payout are all informative about the payout tax schedule $\phi$. More importantly, these three moments help us to identify the agency parameter $\gamma$. The perceived cost to cutting payout clearly affects the variance of the payout. This cost also influences the level of payout as the manager keeps in mind possibility of costly future reductions in payout when choosing the level of payout. The frequency of paying out is affected by both $\gamma$ and $\phi$ making it a good candidate for the SMM. The magnitude of the perceived cost to cutting dividends also influences corporate cash holdings. Thus, the mean and variance of cash-to-assets is also informative about the managerial payout consistency costs.

The first and second moments of equity issuance are informative about the costs of issuing equity. Hence, they are directly informative about the equity issuance cost parameters $\lambda_0$, $\lambda_1$, $\lambda_2$. Costly equity issuance is part of the trade off model and is one of the reasons firms keep cash balances. Therefore, the first and second moments of cash-to-assets are also informative about these parameters.

The correlation between payout and cash holdings provides information about the trade-off between paying out and piling up cash, which is influenced by the payout consistency cost parameter $\gamma$. This correlation sheds light on how firms smooth their payout. In good times firms could take advantage of their higher cash flows to accumulate cash or to distribute to their shareholders.

The variance of investment-to-assets ratio is directly affected by the capital adjustment cost parameter $a$. It is also clear that, through the trade-off in the use of funds, this moment is indirectly informative regarding the payout consistency cost parameter. A manager who associates a disutility to fluctuations in corporate payout will maintain cash as a cushion to avoid volatile distributions. This leads to more consistent and more frequent investments of smaller sizes.[28]

For the constant level of debt $\bar{B}$ and the debt recapitalization cost parameters $\omega$ and $q$, we target three moments of the debt policy. The average debt-to-assets ratio is informative about $\bar{B}$. This is also informative about the position of debt in the financing hierarchy, which also depends on the parameters of the equity issuance cost function. Our estimate of $\omega$ and $q$ ensures that the simulated variance of leverage matches the actual data.[29] The parameters of the recapitalization cost of debt also affect the level of equity issues and cash holdings. As debt recapitalization becomes more costly, equity issues become more attractive to the firm. Cash reserves, as internal financing resources, are another alternative to avoid the cost of issuing equity. Cash holdings are thus also influenced by changes in debt recapitalization cost parameters. Hence, the means of equity issues-to-assets and cash-to-assets are both indirectly informative about $\omega$ and $q$. We also include the frequency of long-term debt reduction as another moment in the SMM. This helps us to identify between the symmetric versus the asymmetric recapitalization cost parameters ($\omega$ versus $q$).

The last set of moments we consider are informative about the production side of the firm. The autoregressive parameter, $\rho$ and the standard deviation, $\sigma$, decribe the stochastic process influencing the production function. To identify these parameters we follow the methodology outlined in Holtz-Eakin et al. (1988) by estimating a first-order panel autoregression of operating income on lagged operating income. The resulting autoregressive parameter and the standard deviation of the regression residual are directly informative about $\rho$ and $\sigma$. In the absence of payout smoothing, when managers follow a residual dividend policy, more volatile income leads to a higher payout variance. Therefore, these moments will also be affected by the managerial payout consistency cost parameter. They also influence the precautionary motive of cash, as higher volatility of shocks and higher persistence of shocks would lead to higher optimal levels of cash holdings.

## 4.3 Simulation and Estimation Results

To mimic the real-world empirical variables, we define the following variables from the simulated panel.

[28] We do not match the mean of investment-to-assets ratio since this moment only responds to the depreciation rate $\delta$ and is not a great choice for identifying any other parameter. We do not endogenously estimate the depreciation rate and set it to 10%.

[29] The recapitalization costs are more relevant to long-term debt than to short-term debt, thus we focus on the variance of long-term debt-to-assets.

$$\frac{NetIncome_t}{TotalAssets_t} = \frac{(1-\tau_c)(f(K_t;\theta_t) - \delta K_t - rB_t)}{K_t}$$

where $f(K_t;\theta_t)$ is from equation (10).

$$\frac{Investment_t}{TotalAssets_t} = \frac{K_{t+1} - (1-\delta)K_t}{K_t}$$

$$\frac{Debt_t}{TotalAssets_t} = \frac{(1+(1-\tau_b)r)B_t}{K_t}$$

$$PayoutRatio = \frac{\max\{0, D_t\}}{NetIncome_t} = \frac{\max\{0, D_t\}}{(1-\tau_c)(f(K_t;\theta_t) - \delta K_t - rB_t)}$$

$$\frac{EquityIssuance_t}{TotalAssets_t} = \frac{-\min\{0, D_t\}}{K_t}$$

$$\frac{CashFlow_t}{TotalAssets_t} = \frac{(1-\tau_f)(f(K_t;\theta_t) - rB_t) + \tau_c \delta K_t}{K_t}$$

Appendix C describes the data and sample selection procedure. Simulation results for the full sample are presented in Table 1. This table compares the actual moments with those from the simulated model using exogenously selected parameter values. The largest inconsistency between the simulated and empirical moments is the over-estimation of the payout variance by roughly a factor of two. We also highlight that the structural model predicts a lower average cash-to-assets ratio. These results support the empirical literature arguing that 1) managers tend to smooth corporate payout, and 2) the high level of cash holdings observed in the data cannot be explained by a trade-off model. The variance of cash-to-assets and the variance of investment-to-assets ratios are also higher than their respective empirical moments.

Since Lintner (1956), there has been a stream of convincing results supporting the tendency of corporations to smooth dividends. To justify this practice, an extensive literature has developed which argues that managers commit to consistent and high payouts to impose self-discipline. However, the empirical work in this area is not compelling. This view features a manager who, during good times, prefers to spend cash on value-destroying expansions of their firms resulting in over-investment and acquisitions (Jensen and Meckling (1976), Moeller et al. (2005), and Harford et al. (2008)) rather than paying out the excess free cash flow. Hence, it has been argued that imposing a high and smooth payout could result in less agency loss due to other inefficacies such as over-investment or excess cash-piling. If first-best policies were achievable, any disutility imposed to the manager would lead to suboptimal policies and equity value relative to the first-best. Our results in Table 1 show that these managers tend to smooth their payouts more than what is required to maximize the equity value of the firm.

Similar to Hennessy and Whited (2007), our estimated second moment of payout is significantly larger than the empirical moment. The observed inconsistency in payout variance reported in Table 1 is consistent with the dividend smoothing puzzle. The second moment of investment-to-assets ratio is also larger than its empirical moment. This could be due to higher capital adjustment costs. However, this moment could also be affected by manager's payout smoothing behavior. This motivates a more rigorous analysis in which we can estimate various model parameters simultaneously, to ensure similar simulated and empirical moments.

The exogenously chosen parameters also lead to overestimation of the payout ratio and the average debt-to-assets ratio. Furthermore, the correlation between corporate payout and cash holdings is smaller in the empirical panel. These results, hand in hand with the low estimate of the first moment of the cash-to-assets ratio, suggest the existence of some external agency parameters influencing the objective function of the firm's manager. When viewed in concert with the overestimation of the payout variance, this evidence suggests that this agency conflict may be due to the cost managers associate with cutting payout.

The standard deviation of the shocks to income-to-assets and the serial correlation of the shocks to income-to-assets from the simulated panel are lower than the same moments from the empirical panel (0.5751 and 0.1317 versus 0.6091 and 0.1483, respectively). This suggests the possibility of inappropriate choices of exogenous parameter values for $\rho$ and $\sigma$. Therefore, when we employ SMM to estimate the agency parameter of the second-best (agency) model, we include the persistence and volatility of the cash flow shocks within the set of model parameters which are endogenously estimated.

[ Insert Table 1 Here ]

We now present estimation results for the SMM estimation for the full sample of firm-years. Table 2 compares the actual moments with those from the simulated agency model. Overall, the first panel's results indicate small differences between the simulated moments and the empirical moments. The payout variance is matched closely to its empirical counterpart as are the payout ratio and frequency of paying out. The mean of the cash-to-assets ratio is still slightly underestimated but has been increased by a factor of three in comparison to the results of the base-case model.[30] The first moment of the equity-to-assets ratio is decreased to slightly below its empirical moment likely due to the increase in the estimated equity issuance cost parameters over the exogenously chosen values for these parameters. Overall, this result suggests that the

[30] There has been a concern with the high level of positive skewness of cash holdings as some firms maintain enormous level of cash causing a long right tail. When comparing the skewness of cash-to-assets of the empirical panel (1.4762) with the simulated panel (1.4543) we find minimal difference. Therefore, we do not include the third moment of cash-to-assets as a moment in the SMM.

agency model in which the manager associates a disutility with cutting dividends, has largely succeeded in matching the simulated moments with the empirical moments.

The second panel of Table 2 contains the estimated model parameters. Estimated persistence ($\rho$) and volatility of the cash flow shocks ($\sigma$) for the full sample are 0.681 and 0.246, and are both statistically significant at the 10% level. The estimates of the debt recapitalization cost parameters ($q, \omega$) and the capital adjustment cost parameter ($a$) are all statistically significant at the 10% level. The estimated average debt ($\bar{B}$) is statistically significant at 1% since it has a direct one to one relationship with the average leverage ratio. The payout tax schedule parameter ($\phi$) is estimated to be 0.318 and is statistically significant at 10%. This estimate is substantially less than the distribution tax schedule parameter found in Hennessy and Whited (2007). We conjecture that this result comes from our inclusion of the perceived cost of payout reduction. In the absence of this agency factor, payout variance is primarily influenced by the distribution tax parameter $\phi$ and so, to attempt to match the payout variance with its low empirical value, this tax parameter has to be very large. This is illustrated in the sensitivity analysis section, where larger values of $\phi$ result in smaller payout variances. Firms try to avoid a large convex tax on payouts, thus they choose to smooth their payouts. However, this motive for payout smoothing alone is not enough to explain the substantially lower payout variance found within the data. Models which do not include managerial disutility for payout reduction, such as Hennessy and Whited (2007), are unable to match the second moment of the distributions precisely. Nevertheless, in an attempt to match this moment with its empirical value, they estimate a large value for $\phi$.

The estimated parameters also decrease the correlation between cash holdings and corporate payout, matching it to its empirical value. Without a cost to payout reductions, both cash accumulation and payout are closely correlated with production. During good days, firms utilize the higher cash flows to accumulate cash and distribute dividends to their shareholders. However, in the agency model, as illustrated below, the perceived cost to cutting payout results in a smaller payout ratio and larger cash balances. This second force acts on the correlation between cash holdings and payout in the opposite direction of the first force, thereby decreasing the large positive correlation to a smaller though still positive correlation.

The equity issuance cost parameters are larger than the exogenously chosen levels indicating higher frictions associated with issuing new equity. While the convex cost parameter $\lambda_2$ is statistically insignificant, $\lambda_0$ and $\lambda_1$ are statistically significant at 5% and 10%, respectively.

The managerial payout consistency parameter $\gamma$ is also statistically significant at the 5% level. The estimated coefficient $\gamma$ is equal to 0.113 which indicates that managers who cut their payout, on average perceive a cost roughly equal to 11% of the magnitude of payout reduction. We discuss the value loss implications for shareholders in detail in later sections. To consider these estimates from an economic perspective, we also calculate the ratio of managerial disutility to equity value. The results illustrate that, on average, for every million dollars of shareholders' equity value, managers associate a cost equivalent to $80,000 for payout reductions.

[ Insert Table 2 Here ]

## 4.4 Sensitivity Analysis

We perform a set of sensitivity analyses to gain a better understanding of the informativeness of the selected moments about model parameters. In particular, we are interested in how the agency parameter affects payout, financing, and corporate savings. Figure 1 presents the results of the comparative statics exercises. These results focus on the two parameters which most directly affect corporate payout policy: $\gamma$ and $\phi$. Using the estimated parameter values from Table 2, we solve the model 15 times while incrementing the changing parameter.

First, we examine the sensitivity of the payout moments (the payout variance, payout ratio, and the frequency of paying out), and a set of important financial and real moments (the average cash-to-assets ratio, the average equity issues-to-assets ratio, variance of investments-to-assets, and the standard deviation of shocks to income-to-assets) to the key agency parameter: the payout consistency cost parameter $\gamma$. We allow $\gamma$ to change from 0 to 0.5. The first seven panels in Figure 1 illustrate the comparative statics for each chosen moment when changing $\gamma$.

The first comparative static illustrates that the payout variance decreases as the managerial consistency cost parameter increases. Although the cost of cutting payout is linear in the size of the payout reduction, the corresponding drop in payout variance is non-linear. The payout variance drops sharply as $\gamma$ increases since by construction of the agency model, the manager chooses to maintain a less volatile payout as she associates higher costs to cutting payouts. With larger values of $\gamma$, the perceived cost of cutting payout becomes large relative to the equity value which results in the manager choosing an almost constant payout policy. This is illustrated by the payout variance approaching zero when $\gamma > 0.20$.

The second panel of Figure 1, illustrates that the payout ratio decreases monotonically with $\gamma$. This is particularly interesting because it shows that a manager who associates large costs to cutting payout will maintain a lower level of payout. On better days, a manager who foresees a cost from reducing future payouts will choose smaller payout increases. When the manager faces a high realization of cash flow shocks, she would rather pay back debt and pile up cash than increase the payout since she takes into account the probability of a reduction in the future payout. This cautious payout policy leads to a lower payout ratio. Unlike the suggestions of Easterbrook (1984) and Jensen (1986), a manager who takes into account the future disutility associated with cutting payout, would maintain a lower payout ratio. Therefore, shareholders imposing a higher cost onto the manager will result in more consistent payout while decreasing the level of payout.

The third panel shows the response of the frequency of paying out to changes in $\gamma$. Interestingly, the payout consistency cost parameter has little effect on the payout frequency. We believe that there are two counteracting forces acting on the payout frequency. In our agency model, a manager who has already committed to a positive payout and receives a low cash flow realization would not fully abandon the payout. This is different from the first-best results where a manager may fully avoid paying out when low shocks are realized. This force would lead to an increase in payout frequency as $\gamma$ increases. On the other hand, a manager who currently has zero payout and experiences an intermediate or low cash flow shock would not initiate a payout. Due to the persistence of cash flow shocks, the manager would foresee future payout cuts and avoid this expected future disutility. This effect works in the opposite direction of the first force. It appears that on average, these two effects cancel each other out leading to the payout frequency remaining unchanged in response to changes in $\gamma$.

The cash-to-assets ratio increases with $\gamma$ since the manager has an additional motive for saving (Panel 4, Figure 1). She saves more cash to use as a cushion against future low realizations of cash flow, allowing her to maintain a more consistent payout. However, the cash-to-assets ratio increases very slowly. An extremely large value of $\gamma = 0.5$ would only increase the cash-to-assets by 18% to 0.17. This suggests that the significantly higher empirical cash holdings (the excess cash puzzle) are not primarily driven by this type of agency conflict.

In our structural model, the firm is also able to issue new equity which is mutually exclusive to paying out. The larger payout consistency cost indirectly leads to a smaller equity issues-to-assets ratio (Panel 5, Figure 1). As $\gamma$ increases the firm becomes more cautious and less volatile in its payout, cash and investment policies. Therefore, the firm relies more on its internal means of financing resulting in smaller costly equity issuances. The reduction in the equity issues-to-assets ratio is due to a lower magnitude of equity proceeds conditional on issuing equity rather than facing the capital markets less frequently.

Panel 6 of Figure 1 shows that the variance of investments decreases with $\gamma$. Structural models such as Hennessy and Whited (2007) overshoot the variance of investments. Hennessy and Whited (2007) argues that incorporating irreversibility into the investment cost function could help to explain the high level of investment variance. We, however, rationalize the investment variance produced by these models through a managerial preference for payout smoothing. A manager who smooths payout will invest in smaller sizes but more often, leading to a lower variance of investment though the average investment is unchanged. In this manner, a preference for consistent payout leads to a less volatile investment policy.

In Panel 7, we illustrate the relationship between the standard deviation of shocks to income-to-assets and the managerial payout consistency cost parameter $\gamma$. A smoother investment policy, resulting from the preference for consistent payout, leads to a less volatile income-to-assets ratio.

Overall, these panels help us understand how different financing and payout moments respond to changes in $\gamma$. These moments are also all endogenously related to each other through their relationship with the managerial preference for consistent payout. The larger cash balances, the lower payout ratio and the smaller equity issuances associated with larger values of $\gamma$ do not support the remedial view of payout smoothing.

In the next three panels we investigate the relationship between the three payout moments with another important model parameter: the payout tax schedule parameter $\phi$. Both $\phi$ and $\gamma$ intensify payout smoothing behavior. However, $\phi$ differs from $\gamma$ in that rather than penalizing reductions in payout, $\phi$ simply penalizes large payout.

Panel 8 shows that the payout variance decreases as the payout tax schedule parameter increases. The payout tax parameter is positively related to the marginal tax rate on corporate payout. As the payout tax parameter increases, due to the convexity of the tax schedule, a manager who cares about the smoothness of the firm's payout avoids large and infrequent dividends by choosing a payout policy which includes distributions that are smaller in magnitude and are paid out more often. This effect results in a less volatile payout. However, as shown in Panel 9, the average payout ratio is not significantly affected by the tax schedule parameter $\phi$. Panel 10 sheds more light on the relationship between the payout policy and the payout tax schedule parameter. The last panel shows that as $\phi$ increases the firm pays out more often. A more frequent payout which is smaller in magnitude leads to a similar payout ratio to a policy featuring large and infrequent distributions. These three panels together illustrate that the payout tax schedule parameter $\phi$ also influences the payout moments of the model.

[ Insert Figure 1 Here ]

## 4.5 Sample Splits and Cross-Sectional Variations

We now examine the role of the payout consistency cost in corporate policies by estimating our dynamic structural model on subsamples that have been split based on different corporate and managerial measures. This helps us to both explore possible heterogeneity in perceived costs of payout reduction across firms and shed light on the motives underlying payout smoothing. For each variable of interest we split the full sample into four quartiles. We report only estimates for the highest and lowest quartile subsamples.[31]

[31] Because our sample split variables are at best rough proxies for the true underlying constructs, we choose to focus on using only the high and low quartiles. This will reduce the possibility that a firm in placed in the wrong subsample.

First, we divide the sample by firm size measured by book assets. Size provides a proxy for several underlying characteristics of the firm which may provide different motives for payout smoothing. Investigating the differences in the estimated agency parameter between the largest and smallest quartiles of the firms, sheds light on the existing heterogeneity of managerial preferences.

Firm size is highly correlated with firm age. Larger and older firms usually have better and cheaper access to credit markets. As in Almeida et al. (2004), it has been argued that payout smoothing can arise from an effort to avoid costly external finance. This would lead one to expect more payout smoothing among smaller firms which have less access to external financing. On the other hand, larger and older firms are more prone to have high levels of free cash flow. For example, Leary and Michaely (2010), and DeAngelo et al. (2009) find a positive relationship between smoothing and the severity of the free cash flow problem. The effect of access to capital and free cash flow move in opposite directions.

Firm size could also proxy for information asymmetry and cash flow uncertainty. Arguably, small firms suffer from more information asymmetry in the market and may also be subject to different real shocks compared to large mature firms. The empirical volatility of the shocks to income-to-assets are significantly greater for smaller firms. Generally speaking, the asymmetric information explanations of payout smoothing suggest that firms facing more uncertainty and greater information asymmetry will tend to smooth more (see for example, Kumar (1988), Brennan and Thakor (1990), Guttman et al. (2001)). This uncertainty also affects corporate cash policy. Smaller firms would need a higher level of cash balances as a precautionary device for possible shortfalls in future cash flow. While in our sensitivity analysis we noted a positive endogenous relationship between cash and payout consistency cost, it is not obvious that this drives the observed higher average cash-to-assets ratio for the smaller firms. For all these reasons, we begin by dividing the sample according to firm size to examine the differences between the estimated parameters across firms.

Columns 1 and 2 of Table 3 report parameter estimates for large and small firms, respectively. Our results indicate a positive association between firm size and managerial payout consistency cost as managers of smaller firms tend to associate less cost to cutting their payouts. The estimated coefficient $\gamma$ is equal to 0.066 for the small firms which is significantly smaller than the coefficient of 0.138 estimated for the large firms. The smaller magnitude of the payout consistency cost among smaller firms indicates that the higher level of cash holdings among these firms is not due to this agency problem. Rather, it can be attributed to the significantly higher standard deviation of shocks to income (0.281 versus 0.133) and larger equity issuance costs. The quadratic equity issuance cost parameter, the debt recapitalization cost parameter and the persistence of the shocks to income-to-assets are not statistically significant for the subsample of small firms.

However, for the large firms subsample, all of the parameters are statistically significant at the 10% level. In general, the behavior of larger firms seems to be more closely aligned with the simulated results. This may follow from larger firms following policies that are more similar in nature to those resulting from a dynamic trade-off model such as ours.

[ Insert Table 3 Here ]

As we just described, firm size could proxy for different firm and managerial characteristics. These results could still mask substantial heterogeneity across firms. In the following splits we select other proxies which attempt to measure relevant firm and managerial characteristics more directly.

We use dispersion of analyst forecasts to measure the degree of information asymmetry between managers and investors. Larger forecast dispersion indicates a poorer information environment. Columns 3 and 4 of Table 3 contain the results for subsamples of high and low analyst forecasts dispersion. The estimated payout consistency parameter is larger for the subsample of high analysts forecasts dispersion (0.126 versus 0.091). This result suggests that managers of firms facing higher levels of information asymmetry perceive larger disutilities from reductions in their payouts. It is interesting to note that the variance of corporate payout does not differ significantly between the two subsamples (0.0017 versus 0.0019). Compared to firms with low analyst forecasts dispersion, firms with high analyst forecasts dispersion experience much higher standard deviation of the shocks to income. The higher volatility of income implies that these firms naturally have higher variance of payouts. The larger estimated managerial payout consistency cost makes the otherwise very large payout variance smaller, thereby leaving the two subsamples with similar payout variances.

Consistent with empirical studies such as Leary and Michaely (2010), the volatility of payout is not significantly different among firms operating in environments featuring high and low levels of information asymmetry. However, the estimates of the managerial payout consistency cost parameter illustrates that information asymmetry is positively related to the perceived cost to payout reductions. In contrast to the conclusions of Leary and Michaely (2010), information asymmetry does have an impact on the preference for smooth payout. This shows, when examining different explanations for empirical facts, the importance of structural models which allow thorough investigation of unobservable managerial preferences.

Columns 5 and 6 contain the parameter estimates for the high and low Pay-Performance Sensitivity (PPS) subsamples. PPS is a measure of managerial incentives which is estimated as the dollar value of the CEO's wealth change for a $1,000 change in shareholders' value. Appendix C elaborates on the calculation of the PPS for each observation. The main component of the PPS is due to CEO ownership of stock and stock options. We employ PPS to measure how closely the CEO's wealth is tied to the shareholders' value. Studies such as Easterbrook (1984) have suggested that enforcement of a smooth payout is an agency-cost treatment to mitigate the agency cost of free cash flow. Because all forms of controlling agency costs are themselves costly, one should expect to see substitution among agency-cost treatments. Payout smoothing should then become less appealing to the shareholders when the manager's incentives are better aligned with those of their shareholders.

Consistent with this explanation, we find that the estimated managerial payout consistency cost is larger for the subsample of low PPS when compared to the estimated parameter for the subsample of high PPS (0.129 versus 0.071, respectively). The high PPS group has a payout variance that is twice as large as the payout variance in the low PPS group.

It is interesting to note that despite a lower payout consistency cost, the cash-to-assets ratio is larger in the high PPS subsample. We have shown ceteris paribus, a lower payout consistency cost will result in smaller cash holdings. So, to explain this discrepancy we must examine the other parameter estimates: the standard deviation of shocks to income and the fixed and the linear equity issuance cost parameters are all larger in the high PPS subsample, while the capital adjustment cost parameter is smaller. The more uncertain cash flows alongside more costly access to equity markets and less smooth investment policy lead to higher precautionary motives for cash holdings. These forces outweigh the effect of the lower payout consistency cost, leading to a larger cash-to assets ratio in the high PPS group.

In Columns 7 and 8 we estimate our model parameters for subsamples of high and low institutional ownership. The importance of institutional investors in monitoring corporate management and influencing payout policy has been investigated in previous studies such as Grinstein and Michaely (2005). Other studies such as Allen et al. (2000) argue that because of institutional investors, dividends can induce "ownership clientele" effects. Due to their tax status, managers can use dividends to attract these investors who have a relative advantage detecting high quality firms and are valued for their monitoring abilities. Once institutional investors have been attracted, they have the ability to impose a large penalty in response to dividend cuts. Managers of firms with high level of institutional holdings are therefore more inclined to maintain consistent payouts.

Our estimates of the managerial payout consistency parameter are in support of Allen et al. (2000). We find that firms with lower institutional ownership have managers who associate smaller perceived costs to reductions in payout. As expected these firms experience higher payout variances. However, the cash-to-assets ratio is not significantly different between the two subsamples. This can be explained by noting that while the lower payout consistency cost and standard deviation of shocks to income induce lower cash balances, the effect of a lower estimated investment adjustment cost and larger fixed equity issuance cost parameter counterbalance these forces giving rise to similar cash-to-assets ratios.

Columns 9 and 10 report parameter estimates for high and low share repurchase-to-payout ratio subsamples. Numerous studies such as Leary and Michaely (2010), Jagannathan et al. (2000) and Skinner (2008) document significant time series variation in repurchase payouts in recent years. This implies that firms typically do not smooth repurchases. While our model does not distinguish between dividends and repurchases, we are still able to test whether managers of firms which pay larger fractions of their payouts in the form of repurchases associate less cost to payout reductions. We construct the ratio of share repurchases to total payout and investigate whether the managerial payout consistency cost is sensitive to the type of payout chosen by the firm.

We find that managers associate less disutility from future payout reductions when they choose to distribute through more flexible share repurchases rather than dividends. This difference is highlighted by the large difference in the payout consistency cost parameter estimates of 0.142 for the low repurchase-to-payout ratio group and 0.051 for the high repurchase-to-payout ratio group.

Finally, we match the simulated to empirical moments using data limited to the years 2002 to 2006. Studies such as Leary and Michaely (2010) have pointed out that the practice of dividend smoothing has increased over time. Although our focus is on total payout smoothing rather than dividend smoothing, our structural model allows us to investigate whether the overall managerial preference for smooth payout has changed in the recent subsample. We also gain insight into the motives underlying the recent growth in cash holdings. The empirical payout variance for this subsample is not significantly smaller than the full sample (0.0013 versus 0.0015). This could be a consequence of the increased popularity of share repurchases in recent years for which, as shown in our previous results, managers tend to associate a smaller consistency cost than for comparable dividend cuts.

We estimate a statistically significant managerial payout consistency cost parameter of 0.124 which is only slightly larger than its estimate for the full sample. Our results seem to show that the high observed cash-to-assets ratio (0.22) is mostly due to a larger estimate of the standard deviation of shocks to income-to-assets (0.337 versus 0.246 in the full sample) rather than as a side effect of a change in the managerial payout consistency cost. This finding is consistent with the empirical study of Bates et al. (2009).

In Panel B of Table 3 we report the equity value loss by comparing the firm in which the manager has incentives to smooth dividends with the same firm where the manager's incentives are perfectly aligned with the shareholders ($\gamma = 0$). We deflate the equity value by the firm's book assets. The reported average value loss is measured as the ratio of the deflated equity value of a firm with aligned incentives to the deflated equity value of the firm with parameters derived from our estimation. Considering the full sample, removing the incentive to smooth dividends results in an increase of 6.6% in shareholders equity value. On average, shareholders at large firms suffer a loss of 8.9% in equity value compared to the 1.2% loss imposed on shareholders of small firms. The largest equity value loss is suffered by shareholders of firms who pay a relatively higher percentage of their distributions in the form of dividends (9.4%). The estimated value losses are larger for firms which suffer from higher information asymmetry, provide less incentives to their managers through compensation, and have higher institutional ownership. In the subsample of recent years, the value loss is similar to the loss estimated for the full sample. This indicates that the effect of payout smoothing on shareholder value has remained constant over time.

# 5 Conclusion

We develop a discrete-time, infinite-horizon, partial equilibrium, stochastic model of payout, investment, debt and cash holdings. In our model, firms trade off a tax benefit of debt against a recapitalization cost of debt. They also save cash in the presence of costly equity issuance and a tax penalty on the cash savings accounts. In the base-case model the firm pays out the residual cash flow after the manager chooses optimal debt, cash and investment policies to maximize equity value in each period. First, we solve this model numerically using exogenously chosen parameters. The moments based on this first-best solution are compared to empirical moments computed from a sample of U.S. firms from 1988 to 2006. The main inconsistencies are the overestimated payout and investment variances, and the underestimated average cash-to-assets ratio.

To address the inconsistencies between the empirical and simulated moments we propose an agency model. Consistent with the empirical literature on payout smoothing and inspired by the low level of empirical payout variance, the objective function of the manager is extended to capture a perceived cost to payout reductions. The functional form of this cost is captured by an additive linear disutility for cutting corporate payout. We employ SMM by matching a set of empirical moments with simulated moments, estimating the managerial payout consistently cost parameter as well as other model parameters such as the persistence and the standard deviation of the shock to income-to-assets, the payout tax schedule parameter and the equity issuance cost parameters.

The results indicate that a manager of a typical firm associates a cost to payout reductions equivalent to ($83,000) for the first million dollars of shareholders' equity value. The SMM parameter estimates support the view that on average managers perceive a fairly large cost for cutting their payout. Moreover, our assumption on the functional form of the payout consistency cost is validated as our model is able to explain both lower than optimal levels of payout variance and investments variance concurrently. This model also helps to explain the high level of corporate cash holdings. Although, as illustrated by comparative statics, the payout consistency cost can only partially explain the larger than optimal cash balances. This suggests other possible explanations for observed excess cash which are beyond the scope of our paper.

We also show that the managerial payout consistency cost accounts for a 6.6% loss in shareholders' equity value. It is important to note that our model does not include any other agency conflicts, nor does it incorporate any sort of information asymmetry. As suggested in the literature, dividend smoothing could be adopted as a remedial policy to mitigate other agency problems or to overcome high levels of information asymmetry and convey credible information to the market. The estimated shareholders' loss in our paper is relative to the first-best equity values for a firm which faces no agency conflicts or information asymmetry. One interesting avenue for future research, therefore, is to attempt to incorporate these other frictions within a structural model to quantify the possible benefits to payout smoothing.

Our comparative statics results show that an increase in the payout consistency cost parameter is associated with reductions in the payout ratio and equity issues as well as an increase in cash balances. We believe that neglecting the joint determination of payout and cash policies and the dynamic effect of requiring smooth dividends by Easterbrook (1984) and Jensen (1986) are the main reasons underlying inconsistencies with their suggestions. This highlights the importance of incorporating a dynamic structural estimation to avoid any sort of endogeneity problems associated with determination of variables such as payout ratio, and cash holdings.

We further explore heterogeneity of the agency parameter across different firms by employing SMM on sample splits based on various firm-manager characteristics. We provide evidence that firms which are larger, have larger analyst forecasts dispersion, have larger institutional ownerships, which compensate their CEOs with low pay-performance packages, and which distribute larger fractions of their payout in the form of dividends, have managers who associate larger costs to cutting their payouts. These results provide partial support for several common explanations of payout smoothing. Interestingly, like Leary and Michaely (2010), we find that differences in information asymmetry does not lead to significantly different payout variances; however, we show that this disguises a significantly larger payout consistency cost parameter estimate for firms with higher analyst forecast dispersion.

Our study focuses on payout smoothing rather than dividend smoothing. In our model, when estimating managerial perceived cost to payout reductions, we do not differentiate between dividends and share repurchases. However, consistent with the empirical literature, our sample split results show that firms which distribute cash to their shareholders through repurchase programs are less inclined to smooth their payout. The differences in the level of managerial commitments associated with each of these methods of payout as well as other institutional differences such as taxes, suggest potentially productive avenues for future research.

# Appendix

## A. Computational Method

In this section we present a method for solving the bellman equation described in Equation 12. To simplify the exposition, we consider a slightly abstracted version consistent with conventions in dynamic programming theory. In particular, Equation 12 can be represented in the following form:

$$V(S_t;\theta_t) = D(S_t, g(S_t;\theta_t)) + \frac{1}{1+r}E_t[V(tr(S_t, g(S_t;\theta_t);\theta_t);\theta_{t+1}) \tag{15}$$

A solution consists of a policy $g : \mathcal{S} \times \Theta \to \mathcal{A}$ which maps a non-stochastic state in $\mathcal{S}$ and stochastic state in $\Theta$ to an action in $\mathcal{A}$. The non-stochastic state space $\mathcal{S}$ accounts for the capital $K_t$, cash $C_t$ and debt $B_t$. The action space accounts for $K_{t+1}$, $C_{t+1}$ and $\Delta B_{t+1}$. The function $D_t : \mathcal{S} \times \mathcal{A} \to \mathbb{R}$ is equal to the dividend payment described in Equation (8). The transition function $tr(\cdot)$ calculates the outstanding debt, and capital and cash on hand at period $t+1$. For capital, cash, and debt the transition function is trivially equal to the respective action variables.

An approximate solution is found by discretizing the state and action space to generate a discrete Markov decision problem which is then solved for the optimal policy using a standard value function iteration algorithm. The state space is composed of an evenly spaced grid with 12 points per variable with the exception of capital stock. Since this is where the majority of the curvature occurs in the model, we use a more finely spaced grid composed of 24 points. The auto-regressive process underlying the stochastic state is approximated with a discrete state Markov chain using the method described in Tauchen (1986). The process is created with 9 states spanning $e^{\pm 3\sigma}$. The discretized transition function selects the closest grid point to the output of the continuous transition function. Ex post, we verify that stable policies do not occur on any boundary points of the state space variables.

We use a slightly altered version of the above methodology in Appendix D which incorporates risky debt into the base-case model. In this model equity holder's have the choice to default if the expected equity value of the firm is negative. The resulting probability of default $\Psi$ is calculated for the product of states and actions, and results in a significant increase in computational complexity.

Together with the fair pricing of debt described in Equation 17, $\Psi$ is used to endogenously calculate interest rate $i_t$. Since fair-pricing itself depends on the value function, the constraint on interest does not allow the bellman equation to fit into the standard dynamic programming structure. However, under reasonable restrictions on the size of interest payments, the Blackwell sufficient condition can be used to show that adding this penalty imposed by the interest charge to

Equation 15 still results in a contraction mapping. This result is sufficient to show the uniqueness and existence of a stable optimal solution. The resulting recursive equation is discretized as above and then solved with an appropriately modified value function iteration algorithm.

## B. Simulated Method of Moments

We use SMM to find a set of parameter values $\vec{\Gamma}^*$ which generate simulated moments $h_n^*(\vec{\Gamma})$ that most closely match empirical moments $H_N^*$. The simulated moments are described by the vector $h_n(\vec{\Gamma})$ which is composed of 14 elements and depends on selected parameter values $\vec{\Gamma}$. The empirical moments are also described by a 14 element vector $H_N$. The moments used in this study consist of first and second order moments of financial ratios, correlations, and regression coefficients.

The vector $\vec{\Gamma}$ is composed of the following 11 parameters

$$\vec{\Gamma} = [\gamma, \lambda_0, \lambda_1, \lambda_2, a, \sigma, \rho, \omega, q, \bar{B}, \phi]$$

The data moments, $\hat{H}_N(X_N)$, are constructed as a 14-member vector of statistics computed from the empirical panel $X_N$ which is a data matrix of length $N$.

In order to estimate the simulated moments, we conduct simulations on the model using a given parameter vector $\vec{\Gamma}$ generating $S = 6$ simulated data sets. $\hat{h_n^s}(x_n^s, \vec{\Gamma})$ is the 14-member vector of the statistics computed from the simulated panel $x_n^s$ which is a data matrix of length $n$ for the particular round of simulation $s$.

The SMM estimator of the parameter vector $\vec{\Gamma}^*$ minimizes the weighted distance between empirical and simulated moments as shown in the following equation:

$$\hat{\vec{\Gamma}} = \underset{\vec{\Gamma}}{\operatorname{argmin}}\, \Delta(\vec{\Gamma})$$

The error metric is defined as

$$\Delta(\vec{\Gamma}) = \left(\hat{H}_N - \frac{1}{S}\sum_{s=1}^{S} h_n^s(\vec{\Gamma})\right)' \hat{W}_N \left(\hat{H}_N - \frac{1}{S}\sum_{s=1}^{S} h_n^s(\vec{\Gamma})\right)$$

where $\hat{W}_N$ is an arbitrary positive definite matrix that converges in probability to a deterministic positive definite matrix $W$. However, we employ the efficient weighting matrix which is the inverse of the estimated covariance of the moments:

$$\hat{W}_N^{eff} = (N\text{var}(\hat{H}_N))^{-1}.$$

We use the influence-function approach in Erickson and Whited (2000) to calculate this covariance matrix.

Hennessy and Whited (2007) show that the indirect estimator ($\vec{\Gamma}$) is asymptotically normal for fixed $S$. Thus, we are able to test for overidentification in our model, with

$$\frac{NS}{1+S}\Big(\hat{H}_N - \frac{1}{S}\sum_{s=1}^{S} h_n^s(\vec{\Gamma})\Big)' \hat{W}_N \Big(\hat{H}_N - \frac{1}{S}\sum_{s=1}^{S} h_n^s(\vec{\Gamma})\Big)$$

converging in distribution to a $\chi^2$ with three degrees of freedom (i.e. the dimension of $H$ minus the dimension of $\vec{\Gamma}$).

Minimizing the error involves a computational search through the space of parameters. We employ a gradient descent approach augmented by an iterated local search metaheuristic (ILS). Lourenço et al. (2003) provides a detailed account of this stochastic local search algorithm. Using ILS, select parameters are perturbed when the gradient descent is unable to find an improving direction ($\frac{\partial\Delta(\vec{\Gamma})}{\partial\Gamma_i} = 0$ for each parameter $\Gamma_i$). Intuitively, ILS provides a framework for a directed search through the set of local minima.

## C. Data and Sample Selection

Accounting data used in this study is drawn from the annual 2006 COMPUSTAT industrial files. We ensure that entries are omitted from regulated, financial and public service firms by deleting entries where the primary SIC is between 4900 and 4999, between 6000 and 6999, or greater than 9000. From the remaining data we remove any firm-years where data is missing or for which total assets, or sales are zero or negative. We also filter-out any firms in the sample which have less than three consecutive years of complete data. The top 1% of the variables in the remaining data entries are winzorized leaving an unbalanced panel of firms from 1988 to 2006 with between 1966 and 3183 observations per year.

Data variables are defined as follows: book assets is Compustat Item 6; gross capital stock is Item 7; investment is the difference between Items 30 and 107; cash flow is the sum of Items 18 and 14; equity issuance is Item 108; total long-term debt is Item 9 plus Item 34; total cash distributions is the sum of Item 19, Item 21, and Item 115; the stock of cash is Item 1; and sales is Item 12. The market-to-book ratio's numerator is defined as book assets minus book equity (item 60) minus balance sheet deferred taxes (item 7) plus the market value of equity (item 199 times item 25). The denominator is book value of assets.

Data on institutional holdings are retrieved from Thomson Financial (previously known as CDA Spectrum), which contains annual information on institutional ownership of stocks listed on NYSE, AMEX, and NASDAQ. Those institutions usually include bank trusts, insurance companies, mutual funds, brokerage firms, pension fund and endowments. Individual blockholders are not covered. We measure institutional holdings using the stock ownership by all the institutional investors. As a robustness check, following Grinstein and Michaely (2005) and Hartzell and Starks (2003) we also measure institutional ownership using the proportion of institutional ownership by the top five institutional investors in the firm (i.e. the summation of the shares owned by the top five institutional investors deflated by the firm's total shares outstanding). Our results are not sensitive to this alternative measure. To measure information asymmetry of a firm, we calculate the standard deviation of analyst annual earning forecasts from IBES.

The executive compensation data is from ExecuComp. Following Jensen and Murphy (1990), Pay-Performance Sensitivity (PPS) is the dollar value of the CEO's wealth change for a $1,000 change in shareholders' value. Although managers can receive pay-performance incentives from a variety of sources, the majority are due to ownership of stock and stock options (Jensen and Murphy (1990)). Similar to Aggarwal and Samwick (2003) and Core and Guay (1999), we compute this sensitivity as the dollar value change of stock and options held by a CEO to a $1,000 shareholder return. For common stock, PPS is simply the fraction of the firm that the executive owns. PPS for options is the fraction of the firm's stock on which the options are written multiplied by the options' delta. We use the method developed by Core and Guay (2002) to estimate option deltas. Their method avoids the cost and difficulty of collecting option data from various proxy statements since it requires information from only the most recent proxy statements. More importantly, the authors show that their estimates are effectively unbiased and 99% correlated with the measures obtained if the parameters of a CEO's option portfolio were completely known.

## D. The Base-Case Model with Risky Debt

Here we investigate how the introduction of risky debt would alter our base-case results.[32] The structure of our risky debt model is related to Moyen (2004) and Moyen (2007). These papers study investment and financing decisions of a firm within an infinite-horizon discrete-time dynamic stochastic framework. In Moyen (2004), unlike our model, there is no need for cash since raising capital is not costly to the firm. In our model with risky debt, firms not only trade off a tax benefit of debt against the expected cost of bankruptcy and the recapitalization cost of debt but also make decisions on the level of cash holdings in the presence of costly equity issuance. Although her model includes dividends, the main purpose of her model differs significantly from

[32] We previously included risky debt in our base-case model; however, it was suggested by the referee to simplify the debt structure since the main focus of the paper is not firm capital structure. Risky debt also significantly adds to the complexity of the numerical solution. Without using a substantially coarser set of grids, it is not possible to find solutions to the SMM problem.

ours as she studies the differences in financial and investment characteristics of firms that face no financing constraint with financially constrained firms.

We construct a discrete-time, infinite-horizon, partial equilibrium, stochastic model of debt, investment and cash holdings. In this model, firms trade off a tax benefit of debt against 1) a default cost of debt and 2) a recapitalization cost for new debt issuances. Similar to the base-case model, the firm maximizes equity value by choosing its dividend, investment, cash holdings, and debt policy. However, the firm's optimization is also subject to fair pricing of any debt issue. All claimants, equity and debt, are risk neutral. The equity value $V_t$ takes the form:

$$V_t = \max\left\{0,\ D_t + T(D_t) + \Lambda(D_t) + \frac{1}{1+(1-\tau_b)r}E_t[V_{t+1}]\right\} \tag{16}$$

Equation (16) shows that the equity value is the sum of the expected discounted stream of dividends, $D_t$. Equation (16) also shows that equity claimants are protected by limited liability. Equity claimants default whenever $D_t + T(D_t) + \Lambda(D_t) + \frac{1}{1+(1-\tau_b)r}E_t[V_{t+1}] \leq 0$. The firm may ask its equity claimants for additional funds ($D_t < 0$), but the equity claimants may choose to relinquish their equity claim rather than contribute more.

Similar to the risk-free debt model, the new debt issue is the difference between the new debt level chosen this period $B_{t+1}$ and the beginning-of-period debt level $B_t$ as in Equation 6. Each period the firm can roll over its existing debt $\Delta B_{t+1} = 0$, retire some debt $\Delta B_{t+1} < 0$, or issue more debt $\Delta B_{t+1} > 0$ at the current interest rate, $i_{t+1}$. Unlike the risk-free debt model, the interest rate requested by creditors can change in each period. This interest rate becomes larger as the firm approaches the default boundary. Fair pricing of debt requires that

$$B_{t+1} = \frac{1}{1+(1-\tau_b)r}E_t[(1+(1-\tau_b)i_{t+1})B_{t+1}\mathbf{1}_{(V_t>0)} + (R(K_{t+1};\theta_{t+1}) - \xi B_{t+1})\mathbf{1}_{(V_t<0)}] \tag{17}$$

Equation (17) shows that debt claimants demand an interest rate such that the debt lent to the firm this period equals next period's expected discounted payoff. The payoff on the debt claim consists of the face value $B_{t+1}$ and the after-tax interest payment $(1-\tau_b)i_{t+1}B_{t+1}$ if equity claimants do not default, or the net residual value $R(K_{t+1};\theta_{t+1}) - \xi B_{t+1}$ if they default, where $\tau_b$ is the debt claimant's interest income tax rate, $\xi$ is the dead weight default cost as a proportion of the debt face value, and the function $\mathbf{1}_{(V_t>0)}$ indicates no default (i.e. it is equal to one if $V_t > 0$ and it is equal to zero other wise).

The residual $R(K_{t+1}, C_{t+1};\theta_{t_1})$ going to the debt claimant upon default is the value of the firm after reorganization. Debt claimants may then recapitalize the firm in an optimal manner. $R(K_{t+1}, C_{t+1};\theta_{t_1})$ captures the optimal recapitalization:

$$R(K_{t+1}, C_{t+1}; \theta_{t+1}) = (1-\tau_c) f(K_t;\theta_t) + \tau_c \delta K_t - I_t + B_{t+1} + \Lambda(D_t) + T(D_t) - \Omega(B_{t+1}, B_t)_{Risky}$$
$$-A(K_{t+1}, K_t) + (1+(1-\tau_c)r)C_t - C_{t+1} + \frac{1}{1+(1-\tau_b)r} E_t[V_{t+1}] \quad (18)$$

The net residual value $R(K_{t+1}, C_{t+1}; \theta_{t_1})$ going to the debt claimants upon bankruptcy (i.e. when $D_t + T(D_t) + \Lambda(D_t) + \frac{1}{1+(1-\tau_b)r} E_t[V_{t+1}] \leq 0$) is always less than the no-default principal after tax interest payment $(1+(1-\tau_b)i_t)B_t$.[33]

As in the risk-free debt structure, we assume a recapitalization cost for debt. However, due to incorporating endogenous default, there is no need to include the symmetric debt adjustment cost and we only include a proportional flotation cost of new debt issues. The new recapitalization cost of debt has the following form

$$\Omega(B_{t+1}, B_t)_{Risky} = q(B_{t+1} - B_t)\mathbf{1}_{(B_{t+1} > B_t)} \quad (19)$$

As in the risk-free model, parameter $q \geq 0$ captures the linear proportional flotation cost of new debt issues.

Using Equations (2),(3), (4), (5), (6), (8), (10), (11), (16), (17), and (19) we can implicitly express the income shock at which equity claimants trigger default, $\bar{\theta}(K_t, B_t, i_t, C_t)$. This is calculated by solving $D_t + T(D_t) + \Lambda(D_t) + \frac{1}{1+(1-\tau_b)r} E_t[V_{t+1}] = 0$ and leads to the following expression for $\bar{\theta}(K_t, B_t, i_t, C_t)$:

$$(1-\tau_c)(\bar{\theta}(K_t, B_t, i_t, C_t)K_t^{\alpha}) + (1-(1-\tau_c)\delta)K_t - K_{t+1} + B_{t+1} - (1+(1-\tau_c)i_t)B_t$$
$$+(1+(1-\tau_c)r)C_t - C_{t+1} + \Lambda(K_t, B_t, i_t, C_t; \bar{\theta}(K_t, B_t, i_t, C_t)) - \Omega(B_{t+1}, B_t; \bar{\theta}(K_t, B_t, i_t, C_t))_{Risky}$$
$$-A(K_t, K_{t+1}; \bar{\theta}(K_t, B_t, i_t, C_t)) + T(K_t, B_t, i_t, C_t; \bar{\theta}(K_t, B_t, i_t, C_t))$$
$$+\frac{1}{1+(1-\tau_b)r} E_t[V_{t+1} | \theta_t = \bar{\theta}(K_t, B_t, i_t, C_t)] = 0 \quad (20)$$

Because $\epsilon_t$ is normally distributed, the income shock follows a log-normal distribution. As a result, the probability of default $\Psi(\bar{\theta}(K_t, B_t, i_t, C_t))$ follows a log-normal cumulative density function.

In this model, the manager maximizes the equity value of the firm such that equations (2)-(6), (8)-(11), (17) and (19) are satisfied. The firm's optimal level of cash holdings depends not only on the cost of issuing equity, but also on the firm's holdings of risky debt and the probability of

[33] The fact that the interest is deductible by the firm at a higher rate than the interest income is taxable to debt claimants ($\tau_c > \tau_b$), implies that the residual is smaller than the principal and after-tax interest going to the debt claimants when no default occurs: $R(K_{t+1}, C_{t+1}; \theta_{t_1}) < (1+(1-\tau_b)i_t)B_t$.

facing costly default. If debt were not risky, the firm could avoid costly equity issues and raise more debt to finance its new investments. In this set up, the expected cost of default on the risky debt as well as the flotation cost of new debt issues, hand in hand with the cost of issuing equity, enables us to address the simultaneous existence of debt and cash balances in the firm.

The manager chooses corporate policies which are also constrained by the bond-pricing Equation (17). She makes these decisions after observing the beginning-of-the-period value for the income shock $\theta_t$ and last period's choices of capital stock $K_t$, debt $B_t$, interest rate $i_t$ and cash stock $C_t$. The Bellman equation describing the firm's intertemporal problem is:

$$V(K_t, B_t, i_t, C_t; \theta_t) =$$
$$\max_{K_{t+1}, \Delta B_{t+1}, i_{t+1}, C_{t+1}} \max \left\{ 0,\ D_t + T(D_t) + \Lambda(D_t) + \frac{1}{1+(1-\tau_b)r} E_t[V(K_{t+1}, B_{t+1}, i_{t+1}, C_{t+1}; \theta_{t+1}] \right\}$$

subject to Equations (2)-(6), (8)-(11), (17) and (19).

The model cannot be solved analytically. The solution is approximated using numerical methods. The employed numerical method, discussed in the Appendix B, is similar to the method used to solve the base-case model with risk-free debt. A sample of 20,000 firms is generated, where each series for which no default occurs ($V_t > 0$) for at least 20 consecutive periods defines a firm. Dropping the first part of the series allows us to observe the firm after it has worked its way out of a possibly suboptimal starting point. Nonetheless, the firms do sometimes default. For example, 0.40% of the firms default in periods 21 to 40. Equity claimants sometimes choose a debt level that is too difficult to service when the realized next period's income shock turns out to be much lower than expected.

Here we compare the Euler equation for optimal cash holdings from the base-case model with risk-free debt (13) with its analog when risky debt is incorporated. The following Euler equation relates the dynamics of interest and probability of default with changes in cash:

$$\begin{aligned}
&1 + (\lambda_1 - \lambda_2 D_t)\mathbf{1}_{(D_t<0)} + (-\tau_d + \tau_d \exp(-\phi D_t))\mathbf{1}_{(D_t>0)} \\
&+ \frac{1}{1+(1-\tau_b)r} E_t[(\tau_c - \tau_b) i_{t+1} + \xi] B_{t+1} \times \\
&\times \Big( \frac{\partial \Psi[\bar{\theta}_(K_{t+1}, B_{t+1}, i_{t+1}, C_{t+1}]}{\partial C_{t+1}} + \frac{\partial \Psi[\bar{\theta}_(K_{t+1}, B_{t+1}, i_{t+1}, C_{t+1}]}{\partial i_{t+1}} . \frac{\partial i_{t+1}}{\partial C_{t+1}} \Big) \ = \\
&= \frac{1+(1-\tau_c)r}{1+(1-\tau_b)r} E_t[1 + (\lambda_1 - \lambda_2 D_{t+1})\mathbf{1}_{(D_{t+1}<0)} + (-\tau_d + \tau_d \exp(-\phi D_{t+1}))\mathbf{1}_{(D_{t+1}>0)}] \\
&+ \frac{1}{1+(1-\tau_b)r} E_t[(\tau_c - \tau_b) B_{t+1} \mathbf{1}_{(V_{t+1}>0)}] . \frac{\partial i_{t+1}}{\partial C_{t+1}} \qquad (21)
\end{aligned}$$

The right hand side represents the shadow value of cash balances and the left hand side represents the marginal cost of external equity finance, the marginal cost from the tax on payout, plus the marginal cost of default on the debt obligations. In addition to factors present in the risk-free model, if a firm saves a dollar today, it also influences both the probability of default and the interest rate promised to the debt claimants in the next period. This equation shows that the firm accounts for the effects of its cash holding decision on the interest rate requested by debt claimants and on the default probability. A higher interest rate $i_{t+1}$ promised to debt claimants translates into a larger tax benefit to the firm, but this higher rate also increases the probability that equity claimants will default on their debt obligation.

[ Insert Table 4 Here ]

Using the same parameters as the base-case model we solved this model numerically. Similar to Moyen (2004), the dead weight cost of default is set to $\xi = 0.1$ to compromise between Fischer et al. (1989) and Kane et al. (1986), who use 5% and 15% of the debt face value for the dead weight cost. Table 4 shows the results. As the Euler equation suggested earlier, the average cash-to-assets ratio is higher than the same ratio in the base-case model with risk-free debt (0.0694 versus 0.0414). However, similar to the base-case model, it overestimates the variance of investment-to-assets ratio. More importantly, with respect to payout variance both models significantly overshoot this moment. This suggests that, although risky debt influences corporate policies such as cash holdings and leverage, it does not help to explain the smooth payout and investment observed in the data. Furthermore, as in our analysis of the base-case model, the results from the model including risky debt with endogenous default suggest a need to incorporate a perceived cost to cutting payout into the manager's utility function.

# References

R.K. Aggarwal and A.A. Samwick. Why do managers diversify their firms? Agency reconsidered. *The Journal of Finance*, 58(1):71–118, 2003.

V.A. Aivazian, L. Booth, and S. Cleary. Dividend smoothing and debt ratings. *Journal of Financial and Quantitative Analysis*, 41(02):439–453, 2009.

F. Allen, A.E. Bernardo, and I. Welch. A theory of dividends based on tax clienteles. *The Journal of Finance*, 55(6):2499–2536, 2000.

H. Almeida, M. Campello, and M.S. Weisbach. The cash flow sensitivity of cash. *The Journal of Finance*, 59(4):1777–1804, 2004.

O. Altinkiliç and RS Hansen. Are there economies of scale in underwriting fees? Evidence of rising external financing costs. *Review of Financial Studies*, 13(1):191–218, 2000.

T.W. Bates, K.M. Kahle, R.M. Stulz, and M.C. Hall. Why do US firms hold so much more cash than they used to? *Journal of Finance*, Forthcoming, 2009.

L. Booth and Z. Xu. Who Smoothes Dividends?

A. Brav, J.R. Graham, C.R. Harvey, and R. Michaely. Payout policy in the 21st century. *Journal of Financial Economics*, 77(3):483–527, 2005.

M.J. Brennan and A.V. Thakor. Shareholder preferences and dividend policy. *Journal of Finance*, 45(4):993–1018, 1990.

H. Choe. *Intertemporal and cross-sectional variation of corporate dividend policy.* PhD thesis, Univ. of Chicago, Graduate School of Business, 1990.

R.W. Cooper and J.C. Haltiwanger. On the Nature of Capital Adjustment Costs. *Review of Economic Studies*, 73(3):611–633, 2006.

J. Core and W. Guay. The use of equity grants to manage optimal equity incentive levels. *Journal of Accounting and Economics*, 28(2):151–184, 1999.

J. Core and W. Guay. Estimating the value of employee stock option portfolios and their sensitivities to price and volatility. *Journal of Accounting Research*, 40(3):613–630, 2002.

H. DeAngelo, L. DeAngelo, and D.J. Skinner. *Corporate payout policy.* 2009.

A. Dittmar and J. Mahrt-Smith. H. Servaes, 2003, International corporate governance and corporate cash holdings. *Journal of Financial and Quantitative Analysis*, 38(1):111–133, 2003.

A. Dittmar and J. Mahrt-Smith. Corporate governance and the value of cash holdings. *Journal of Financial Economics*, 83(3):599–634, 2007.

F.H. Easterbrook. Two agency-cost explanations of dividends. *The American Economic Review*, pages 650–659, 1984.

T. Erickson and T.M. Whited. Measurement error and the relationship between investment and q. *Journal of Political Economy*, 108(5):1027–1057, 2000.

E.F. Fama and H. Babiak. Dividend policy: An empirical analysis. *Journal of the American Statistical Association*, 63(324):1132–1161, 1968.

M. Faulkender and R. Wang. Corporate Financial Policy and the Value of Cash. *The Journal of Finance*, 61(4):1957–1990, 2006.

E.O. Fischer, R. Heinkel, and J. Zechner. Dynamic Capital Structure Choice: Theory and Tests. *Journal of Finance*, 44(1):19–40, 1989.

A. Gamba and A.J. Triantis. The Value of Financial Flexibility. *The Journal of Finance*, 63: 2263–2296, 2008.

Y. Grinstein and R. Michaely. Institutional holdings and payout policy. *The Journal of Finance*, 60(3):1389–1426, 2005.

I. Guttman, O. Kadan, and E. Kandel. A Theory of Dividend Smoothing1. *Working Paper*, 2001.

J. Harford. Corporate cash reserves and acquisitions. *Journal of Finance*, pages 1969–1997, 1999.

J. Harford, S.A. Mansi, and W.F. Maxwell. Corporate governance and firm cash holdings in the US. *Journal of Financial Economics*, 87(3):535–555, 2008.

J.C. Hartzell and L.T. Starks. Institutional investors and executive compensation. *The Journal of Finance*, 58(6):2351–2374, 2003.

C. Hennessy and T. Whited. How Costly is External Financing? Evidence from a Structural Estimation. *Journal of Finance*, 62:1705–1745, 2007.

D. Holtz-Eakin, W. Newey, and H.S. Rosen. Estimating vector autoregressions with panel data. *Econometrica*, pages 1371–1395, 1988.

M. Jagannathan, C.P. Stephens, and M.S. Weisbach. Financial flexibility and the choice between dividends and stock repurchases. *Journal of financial Economics*, 57(3):355–384, 2000.

M. Jensen and W. Meckling. Theory of the firm: Managerial behavior, agency costs, and capital structure. *Journal of financial economics*, 3(4):305–360, 1976.

M.C. Jensen. Agency Cost Of Free Cash Flow, Corporate Finance, and Takeovers. *American Economic Review*, 76(2), 1986.

M.C. Jensen and K.J. Murphy. Performance pay and top-management incentives. *Journal of political economy*, 98(2), 1990.

I. Kalcheva and K.V. Lins. International evidence on cash holdings and expected managerial agency problems. *Review of Financial Studies*, 20(4):1087, 2007.

A. Kane, A.J. Marcus, and R.L. McDonald. Debt Policy and the Rate of Return Premium to Leverage. *NBER Working Paper*, 1986.

P. Kumar. Shareholder-manager conflict and the information content of dividends. *Review of Financial Studies*, 1(2):111–136, 1988.

P. Kumar and B.S. Lee. Discrete dividend policy with permanent earnings. *Financial Management*, 30(3):55–76, 2001.

M.T. Leary and R. Michaely. Determinants of Dividend Smoothing: Empirical Evidence. *Working Paper*, 2010.

K. Li and X. Zhao. Asymmetric information and dividend policy. *Financial Management*, 37 (4):673–694, 2008.

J. Lintner. Distribution of incomes of corporations among dividends, retained earnings, and taxes. *The American Economic Review*, 46(2):97–113, 1956.

H.R. Lourenço, O.C. Martin, and T. Stutzle. Iterated local search. *INTERNATIONAL SERIES IN OPERATIONS RESEARCH AND MANAGEMENT SCIENCE*, pages 321–354, 2003.

A. Michaelides and S. Ng. Estimating the rational expectations model of speculative storage: A Monte Carlo comparison of three simulation estimators. *Journal of econometrics*, 96(2): 231–266, 2000.

W.H. Mikkelson and M.M. Partch. Do persistent large cash reserves hinder performance? *Journal of Financial and Quantitative Analysis*, pages 275–294, 2003.

S.B. Moeller, F.P. Schlingemann, and R.M. Stulz. Wealth destruction on a massive scale? A study of acquiring-firm returns in the recent merger wave. *Journal of Finance*, pages 757–782, 2005.

N. Moyen. Investment-Cash Flow Sensitivities: Constrained versus Unconstrained Firms. *The Journal of Finance*, 59(5):2061–2092, 2004.

N. Moyen. How big is the debt overhang problem? *Journal of Economic Dynamics and Control*, 31(2):433–472, 2007.

N. Moyen and M. Boileau. Corporate Precautionary Savings. *University of Colorado Working Paper*, 2009.

B. Nikolov and T.M. Whited. Agency Conflicts and Cash: Estimates from a Structural Model. *University of Rochester Working Paper*, 2010.

T. Opler, L. Pinkowitz, and R. Stulz. R. Williamson, 1999. The determinants and implications of corporate cash holdings. *Journal of Financial Economics*, 52(1), 1999.

L. Pinkowitz, R. Stulz, and R. Williamson. Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis. *Journal of Finance*, 61:2725–2751, 2006.

L.A. Riddick and T.M. Whited. The Corporate Propensity to Save. *The Journal of Finance*, forthcoming, 2008.

D.J. Skinner. The evolving relation between earnings, dividends, and stock repurchases. *Journal of Financial Economics*, 87(3):582–609, 2008.

G. Tauchen. Finite State Markov-Chain Approximations to Univariate and Vector Autoregressions. *Economics Letters*, 20(2):177–81, 1986.

Table 1: Exogenously Simulated and Empirical Moments for the Full Sample

This table reports the simulated and empirical moments using the base-case model. The empirical moments are based on a sample of non-financial, unregulated firms from the annual 2006 COMPUSTAT industrial files. The sample period is 1988 to 2006. Estimation is done using the base-case model and the exogenously chosen parameter values. The simulated panel of firms is generated from the base-case model described in Section 3.1, and contains 20,000 firms over 40 time periods, where only the last 19 time periods are kept for each firm.

| Name of Moments | Empirical Moments | Simulated Moments |
|---|---|---|
| Average Cash/Assets | 0.1631 | 0.0414 |
| Variance of Cash /Assets | 0.0436 | 0.0514 |
| Variance of Investment/Assets | 0.0069 | 0.0139 |
| Average Equity Issuance/Assets | 0.0368 | 0.0305 |
| Variance of Equity Issuance/Assets | 0.0593 | 0.0638 |
| Payout ratio | 0.2072 | 0.2284 |
| Variance of Payout | 0.0015 | 0.0025 |
| Frequency of Paying Out | 0.4511 | 0.4923 |
| Average Debt/Assets | 0.2682 | 0.3142 |
| Variance of Long-Term Debt/Assets | 0.0712 | 0.0858 |
| Frequency of Long-Term Debt Reduction | 0.6483 | 0.5730 |
| Correlation of Payout and Cash/Assets | 0.0543 | 0.2131 |
| Standard Deviation of the Shock to Income/Assets | 0.1483 | 0.1317 |
| Serial Correlation of Income/Assets | 0.6091 | 0.5751 |

Table 2: Matching Moments and Estimated Model Parameters for the Full Sample

This table shows empirical and simulated moments with associated parameter estimates. Empirical moments are based on a sample of non-financial, unregulated firms from years 1988 to 2006 of the 2006 COMPUSTAT industrial files. The parameter estimation is done using SMM to match moments of a simulated panel to corresponding empirical moments. The simulated moments are from a data panel generated from the agency model (Section 3.2) with estimated parameters. This panel includes 20,000 simulated firms for which the last 19 of 40 time periods are retained. Empirical and simulated moments are reported in Panel A. Panel B reports the estimated parameters, including p-values in parentheses. Estimated parameters include: the fixed, linear and quadratic equity issuance cost parameters $\lambda_0, \lambda_1, \lambda_2$; the payout consistency cost parameter $\gamma$; the debt adjustment, flotation cost of new debt issues and constant target debt parameters $\omega, q, \bar{B}$; the payout tax schedule parameter $\phi$; the capital adjustment cost parameter $a$; and the standard deviation and serial correlation of the cash flow shock parameters $\sigma, \rho$. The final entry, $\chi^2$, reports the chi-squared statistic for the test of the overidentifying restrictions. Its p-value is reported in parentheses.

Panel A: Moments

| Name of Moments | Empirical Moments | Simulated Moments |
|---|---|---|
| Average Cash/Assets | 0.1631 | 0.1458 |
| Variance of Cash /Assets | 0.0436 | 0.0354 |
| Variance of Investment/Assets | 0.0069 | 0.0061 |
| Average Equity Issuance/Assets | 0.0368 | 0.0316 |
| Variance of Equity Issuance/Assets | 0.0593 | 0.0503 |
| Payout ratio | 0.2072 | 0.1929 |
| Variance of Payout | 0.0015 | 0.0013 |
| Frequency of Paying Out | 0.4511 | 0.4532 |
| Average Debt/Assets | 0.2682 | 0.2693 |
| Variance of Long-Term Debt/Assets | 0.0712 | 0.0606 |
| Frequency of Long-Term Debt Reduction | 0.6483 | 0.6328 |
| Correlation of Payout and Cash/Assets | 0.0543 | 0.0594 |
| Standard Deviation of the Shock to Income/Assets | 0.1483 | 0.1501 |
| Serial Correlation of Income/Assets | 0.6091 | 0.6169 |

Panel B: Estimated Parameters

| $\lambda_0$ | $\lambda_1$ | $\lambda_2$ | $\gamma$ | $\omega$ | $q$ |
|---|---|---|---|---|---|
| 0.481 | 0.070 | 0.0002 | 0.113 | 0.045 | 0.042 |
| (0.084) | (0.037) | (0.123) | (0.048) | (0.085) | (0.079) |
| $\bar{B}$ | $\phi$ | $a$ | $\rho$ | $\sigma$ | $\chi^2$ |
| 13.541 | 0.318 | 0.541 | 0.681 | 0.246 | 7.42 |
| (0.008) | (0.093) | (0.087) | (0.058) | (0.066) | (0.059) |

## Table 3: Estimated Model Parameters for Different Sample Splits

This table shows parameter estimates and equity value losses for different sample splits. Empirical moments are based on a sample of non-financial, unregulated firms from years 1988 to 2006 of the 2006 COMPUSTAT industrial files. The parameter estimation is done using SMM to match moments of a simulated panel to corresponding empirical moments. The simulated moments are from a data panel generated from the agency model (Section 3.2) with estimated parameters. This panel includes 20,000 simulated firms for which the last 19 of 40 time periods are retained. Panel A reports the estimated model parameters for different sample slits, with p-values in parentheses. The sample is split with respect to high and low i) firms size, ii) analyst forecasts dispersion, iii) CEO pay-performance sensitivity, iv) institutional ownership, and v) share repurchase to total payout ratio. We also include a subsample of firm-years from the sub-period of 2002-2006. High and low refer to the first and last quartiles of the distribution, respectively. Estimated parameters include: the fixed, linear and quadratic equity issuance cost parameters $\lambda_0, \lambda_1, \lambda_2$; the payout consistency cost parameter $\gamma$; the debt adjustment, flotation cost of new debt issues and constant target debt parameters $\omega, q, \bar{B}$; the payout tax schedule parameter $\phi$; the capital adjustment cost parameter $a$; and the standard deviation and serial correlation of the cash flow shock parameters $\sigma, \rho$. The final entry, $\chi^2$, reports the chi-squared statistic for the test of the overidentifying restrictions. Its p-value is reported in parentheses. Panel B reports the equity value loss due to the misalignment of incentives between managers and shareholders. Equity value is deflated by the capital stock. Equity value loss is measured as the ratio of the value of a firm with no agency conflicts (i.e. $\gamma = 0$) to the value of a firm described by our agency model using the estimated parameters.

Panel A: Estimated Structural Parameters for Different Sample Splits

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Estimated Parameters | Large Firms | Small Firms | High Info. Asymmetry | Low Info. Asymmetry | High PPS | Low PPS | High Inst. Holdings | Low Inst. Holdings | High Share Rep. Ratio | Low Share Rep. Ratio | Period of 2002-2006 |
| $\lambda_0$ | 0.391 | 0.894 | 0.462 | 0.373 | 0.569 | 0.372 | 0.431 | 0.572 | 0.746 | 0.398 | 0.462 |
| | (0.092) | (0.094) | (0.075) | (0.069) | (0.043) | (0.068) | (0.058) | (0.063) | (0.072) | (0.054) | (0.079) |
| $\lambda_1$ | 0.058 | 0.098 | 0.051 | 0.086 | 0.073 | 0.049 | 0.068 | 0.072 | 0.081 | 0.047 | 0.081 |
| | (0.055) | (0.072) | (0.067) | (0.069) | (0.062) | (0.071) | (0.079) | (0.081) | (0.083) | (0.061) | (0.085) |
| $\lambda_2$ | 0.0003 | 0.0004 | 0.0002 | 0.0003 | 0.0003 | 0.0003 | 0.0002 | 0.0003 | 0.0003 | 0.0002 | 0.0003 |
| | (0.232) | (0.183) | (0.274) | (0.0289) | (0.341) | (0.286) | (0.189) | (0.218) | (0.174) | (0.106) | (0.238) |
| $\gamma$ | 0.138 | 0.066 | 0.126 | 0.091 | 0.071 | 0.129 | 0.131 | 0.059 | 0.051 | 0.142 | 0.124 |
| | (0.028) | (0.063) | (0.041) | (0.058) | (0.051) | (0.047) | (0.039) | (0.048) | (0.058) | (0.041) | (0.029) |
| $\omega$ | 0.015 | 0.059 | 0.061 | 0.021 | 0.034 | 0.039 | 0.021 | 0.054 | 0.029 | 0.049 | 0.023 |
| | (0.074) | (0.121) | (0.082) | (0.096) | (0.082) | (0.103) | (0.089) | (0.094) | (0.088) | (0.112) | (0.090) |
| $q$ | 0.024 | 0.068 | 0.062 | 0.014 | 0.033 | 0.046 | 0.021 | 0.053 | 0.031 | 0.052 | 0.038 |
| | (0.091) | (0.095) | (0.058) | (0.067) | (0.073) | (0.079) | (0.091) | (0.078) | (0.085) | (0.072) | (0.069) |
| $\bar{B}$ | 14.59 | 3.12 | 4.95 | 15.12 | 7.48 | 15.34 | 12.38 | 9.13 | 6.93 | 15.82 | 13.75 |
| | (0.002) | (0.010) | (0.004) | (0.003) | (0.008) | (0.004) | (0.002) | (0.007) | (0.002) | (0.003) | (0.007) |
| $\phi$ | 0.302 | 0.581 | 0.281 | 0.277 | 0.315 | 0.298 | 0.184 | 0.410 | 0.217 | 0.412 | 0.307 |
| | (0.079) | (0.178)) | (0.071) | (0.083) | (0.075) | (0.082) | (0.074) | (0.091) | (0.077) | (0.065) | (0.091) |
| $a$ | 0.352 | 0.697 | 0.613 | 0.391 | 0.371 | 0.639 | 0.702 | 0.308 | 0.517 | 0.405 | 0.478 |
| | (0.047) | (0.074) | (0.038) | (0.044) | (0.048) | (0.058) | (0.041) | (0.059) | (0.047) | (0.038) | (0.068) |
| $\rho$ | 0.784 | 0.548 | 0.601 | 0.713 | 0.671 | 0.702 | 0.712 | 0.668 | 0.627 | 0.768 | 0.671 |
| | (0.061) | (0.111) | (0.130) | (0.092) | (0.084) | (0.076) | (0.089) | (0.103) | (0.083) | (0.079) | (0.079) |
| $\sigma$ | 0.133 | 0.271 | 0.299 | 0.114 | 0.269 | 0.186 | 0.216 | 0.287 | 0.305 | 0.169 | 0.337 |
| | (0.083) | (0.079) | (0.068) | (0.088) | (0.061) | (0.069) | (0.058) | (0.073) | (0.068) | (0.055) | (0.061) |
| $\chi^2$ | 7.21 | 8.03 | 7.45 | 7.89 | 6.95 | 7.36 | 6.94 | 6.68 | 8.01 | 6.78 | 7.14 |
| | (0.065) | (0.045) | (0.059) | (0.048) | 0.073 | 0.061 | 0.074 | 0.083 | 0.046 | 0.079 | 0.067 |

Panel B: Equity Value Loss

| Full Sample | Large Firms | Small Firms | High Info. Asymmetry | Low Info. Asymmetry | High PPS | Low PPS | High Inst. Holdings | Low Inst. Holdings | High Share Rep. Ratio | Low Share Rep. Ratio | Period of 2002-2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.066 | 1.089 | 1.012 | 1.071 | 1.034 | 1.024 | 1.073 | 1.087 | 1.028 | 1.023 | 1.094 | 1.068 |

Table 4: Exogenously Simulated and Empirical Moments for the Full Sample: The Risky Debt Model

This table reports the simulated and empirical moments using the base-case model with risky debt. The empirical moments are based on a sample of non-financial, unregulated firms from the annual 2006 COMPUSTAT industrial files. The sample period is 1988 to 2006. Estimation is done using the base-case model including risky debt and the exogenously chosen parameter values. The simulated panel of firms is generated from the base-case model with risky debt as described in Appendix D, and contains 20,000 firms over 40 time periods, where only the last 19 time periods are kept for each firm.

| Name of Moments | Empirical Moments | Simulated Moments |
|---|---|---|
| Average Cash/Assets | 0.1631 | 0.0694 |
| Variance of Cash /Assets | 0.0436 | 0.0483 |
| Variance of Investment/Assets | 0.0069 | 0.0126 |
| Average Equity Issuance/Assets | 0.0368 | 0.0963 |
| Variance of Equity Issuance/Assets | 0.0593 | 0.0698 |
| Payout ratio | 0.2072 | 0.2013 |
| Variance of Payout | 0.0015 | 0.0024 |
| Frequency of Paying Out | 0.4511 | 0.4839 |
| Average Debt/Assets | 0.2682 | 0.1905 |
| Variance of Long-Term Debt/Assets | 0.0712 | 0.0786 |
| Frequency of Long-Term Debt Reduction | 0.6483 | 0.6893 |
| Correlation of Payout and Cash/Assets | 0.0543 | 0.2067 |
| Standard Deviation of the Shock to Income/Assets | 0.1483 | 0.1012 |
| Serial Correlation of Income/Assets | 0.6091 | 0.5113 |

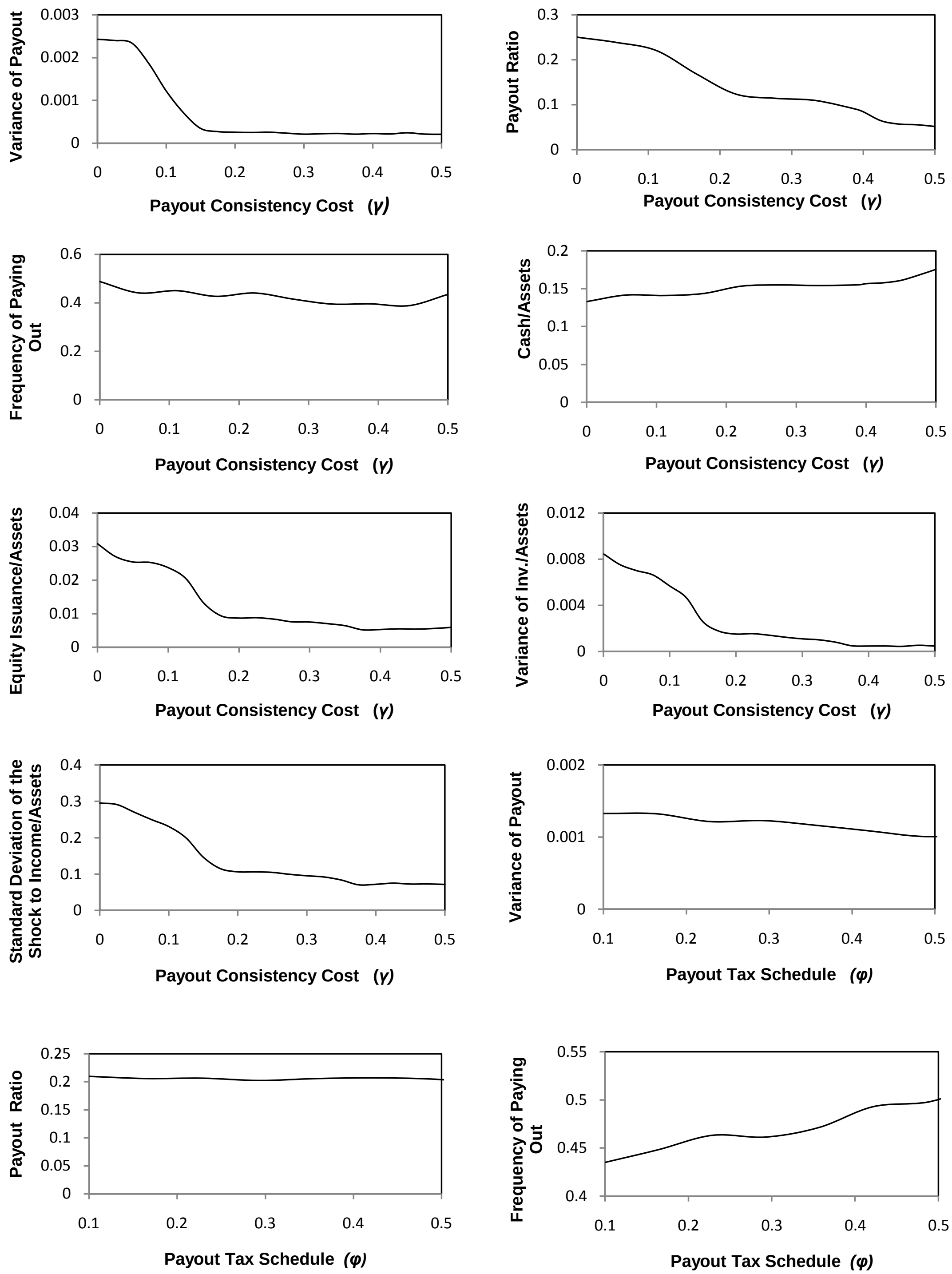


Figure 1: Sensitivity Analysis of Model Moments to Payout Parameters

This figure shows comparative statics relating first, the Payout Consistency Cost parameter ($\gamma$) with 1) variance of payout, 2) payout ratio, 3) frequency of paying out, 4) cash-to-assets ratio, 5) equity issuance-to-assets ratio, 6) variance of investment-to-assets ratio, 7) standard deviation of the shock to income-to-assets ratio, and, second, the Payout Tax Schedule parameter ($\phi$) with 8) variance of payout, 9) payout ratio, and 10) frequency of paying out.